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TYPES OF FARMING IN CANADA¹

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I. GEOGRAPHICAL NOTES

"The Dominion of Canada comprises the whole northern half of the North American continent except the United States territory of Alaska, and the Coast of Labrador, a dependency of the Colony of Newfoundland. . . . It is bounded on the west by the Pacific Ocean and Alaska, on the south by the 49th parallel, the Great Lakes, the St. Lawrence river and additional lines set out by the Ashburton Treaty, signed August 9th, 1842; and on the east by the Atlantic ocean, the gulf of St. Lawrence, the territory of the Coast of Labrador, (as defined by the award of the Privy Council, March 1st, 1927,) and Davis strait."³ The Dominion stretches northward to the polar regions. The total area is officially reported at 3,690,043 square miles, approximately the area of the United States and its dependent territories.

There are five major natural divisions of the Dominion territory. The Canadian or Precambrian shield, covering some 2,500,000 square miles, includes most of the area north of the St. Lawrence, Great Lakes, Lake Winnipeg, and northwest to the Mackenzie River. The Appalachian region, south of the St. Lawrence and east of Quebec, continues in Canada the Green Mountains of Vermont, and the highlands of Maine. The Lowlands of the St. Lawrence, which extend from below Quebec to Lake Huron, constitute a third division between these two previous divisions and the Great Lakes, and support a fertile and diversified agriculture. The Great Plains, with their threefold division into prairie steppes, extend from the southwestern edge of the Canadian shield to the Rockies. The Rockies, or Cordilleras, which constitute the western mountain belt, cover some 600,000 square miles.

II. HISTORICAL NOTES

Five years after Columbus discovered America, John Cabot discovered Labrador and extended his expeditions along the coast to the north. Labrador was visited by Costereal in 1501 after his discovery of Newfoundland. In 1525, Verazzani explored the coast of America from Florida to Newfoundland, and gave the name of New France to the country discovered. Jacques Cartier landed as Gaspé Bay in 1534, and took possession of the land in the name of France. After returning to France he came back the following year and explored the St. Lawrence as far as Hochelaga (Montreal). In 1541, he made a third trip from France, bringing volunteers to form a colony which failed disastrously. Little more was heard in Europe of the new country for over

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³Canada Year Book 1932, p. 1.

half a century. In 1598, attempts at colonization were made at Acadia (Nova Scotia) which were unsuccessful. That year the Marquis de la Roche also landed 60 convicts on Sable Island, a narrow island some 25 miles long about 100 miles south-east of the mainland of Nova Scotia, where they remained prisoners for five years.

A few years earlier, (1592), Juan de Fuca discovered the strait which bears his name, which marks the south Pacific limits of the Dominion. This strait separates southern Vancouver Island from the mainland of British Columbia and the State of Washington.

With the beginning of the next century, exploration proceeded apace, and settlements became established at many points. Some of the earliest were at Acadia and Quebec. In 1610-11 Henry Hudson made his famous expedition along the Northern coast and explored Hudson Bay and James Bay. British settlement of Nova Scotia began in 1623, very shortly after the arrival of the *Mayflower* at Plymouth Rock. The charter of the Hudson's Bay Company was granted by Charles II in 1670 and for 200 years all the territory of Hudson Bay was under the control of the Company, and operated by Indians and fur traders. As the century progressed, explorations, settlements, and conflicts were numerous. Struggles between French and British continued until 1763, when, by the Treaty of Paris, Canada and its dependencies were ceded to the British.

With the close of the American Revolution in 1775 came a large influx of United Empire Loyalists, who settled in Nova Scotia, New Brunswick, the eastern townships of Quebec, and also westward along the banks of the St. Lawrence and the Great Lakes.

In 1811, Lord Selkirk's Red River settlement was founded on land granted by the Hudson's Bay Company near to the present site of Winnipeg. The settlement was destroyed by the Northwest Company, an active rival of the Hudson's Bay Company, and after being restored was again destroyed. The antagonism of the rival companies ended in 1821, when the Northwest Company was absorbed by the Hudson's Bay Company.

Confederation of the scattered provinces came through the British North America Act of 1867. In 1871, British Columbia was brought into the Dominion and the transcontinental railway projected; this was commenced in 1875 by the government and subsequently completed in 1886 by the Canadian Pacific Railway Company. Indian uprisings were frequent through the early periods but ceased with the subduing of the second Riel rebellion in 1885. With the building of the transcontinental railway came fairly rapid settlement of the open prairies through grants of free homestead land. At the present time, lands suitable for settlement are confined to northern areas, and few extensive tracts remain unappropriated.

III. GENERAL REGIONAL NOTES

For the purpose of this discussion of farm types the provinces have been grouped according to their locations. The eastern group, or the maritime provinces, includes Prince Edward Island, Nova Scotia, and New Brunswick. The central group includes Quebec and Ontario. The prairie group consists of Manitoba, Saskatchewan and Alberta. The Pacific province, British

Columbia, is considered alone. At the present time, the agricultural significance of the Northwest Territories is negligible.

The maritime provinces contain only about 6% of the occupied farm land of the Dominion, but in 1931 had 9.7% of the total Canadian population. Nearly one-half of the potential farm land has been brought into farms. Of the total land area, 62% is estimated to be of potential farm land calibre. Practically all of Prince Edward Island is under farms. Nova Scotia and New Brunswick have considerable lands unfit for farming, and of their potential farm land, according to the official estimates, more than one-half is still undeveloped.

The agricultural sections of the central provinces are found in the lowlands of the St. Lawrence. These extend from the Gaspé peninsula in narrow belts steadily increasing in width for about 650 miles along the St. Lawrence. Around the Great Lakes the area continues some 300 miles to the Ontario peninsula between Lakes Ontario and Huron, and occupies much of the region south of the Ottawa river. The agricultural lands of the central provinces are practically all within the lowlands of the St. Lawrence, with the exception of the clay belts to the north. The official estimate of the potential agricultural lands of this section of Canada is 110 million acres, (30% of the total of the Dominion). Of this area about 40% has already been included in farms.

TABLE 1.—*Estimated area of land, potential farm land, and occupied farm land in Canada by provinces, 1931**

Provinces	Total area 000,000's acres	Estimated potential farm land		Occupied as farm land, 1931, 000,000's acres	Per cent of potential farm land occupied in 1931
		000,000's acres	Per cent of total		
Maritime					
Prince Edward Island	1.40	1.26	90.0	1.19	94.6
Nova Scotia	13.28	8.09	61.0	4.30	53.1
New Brunswick	17.73	10.72	60.4	4.15	38.7
Total	32.41	20.07	61.9	9.64	48.0
Central					
Quebec	365.44	43.74	12.1	17.76	40.5
Ontario	232.50	66.87	28.7	21.98	32.9
Total	597.94	110.61	18.5	39.74	35.9
Prairie					
Manitoba	143.86	24.70	17.2	15.14	60.9
Saskatchewan	152.30	93.46	61.4	55.66	59.6
Alberta	159.23	97.12	61.0	38.98	40.1
Total	455.39	215.28	47.3	109.78	51.0
Pacific					
British Columbia	223.98	22.61	10.0	3.36	14.8
Dominion Total	1309.72	368.57	28.1	162.52	44.1

*Based on data in Table 45 of the Canada Year Book, 1932, p. 1066.

After leaving the western extremity of the Ontario agricultural region the rough lands of the Precambrian shield occupy some 800 to 1000 miles of Ontario and Manitoba. Beyond this, the Canadian Great Plains stretch some 750 miles, rising gradually to the foothills of the Rockies, and generally increasing in width with the distance travelled westward. Within the prairie provinces are found about 60% of the potential agricultural land of the Dominion, of which 51% had been occupied in 1931.

West of the prairies, in the valleys between the mountain ranges, and on the Pacific coastal plain, British Columbia carries on her diversified agriculture. Official estimates of the agricultural land of this province claim 22.6 million acres, rather more than in the maritimes, of which 14.9% had been included in farms in 1931.

Table 1 presents official data relating to the total area of land, to the potential farm lands and to land occupied by farms in 1931, by provinces, by regional groups, and for the Dominion.

IV. GROSS AGRICULTURAL REVENUE

To supplement the foregoing information, a statement of the average gross agricultural revenue for the five years 1927 to 1931 has been presented for provinces and regions in Table 2. The general sources from which farm receipts have been derived are indicated.

TABLE 2.—*Gross agricultural revenue of Canada. Annual average for five years, 1927 to 1931, in millions of dollars.**

	Field crops	Farm animals	Wool	Dairy products	Fruits and vegetables	Poultry and	Fur farming	Other products	Total
Maritime									
Prince Edward Island	12.1	2.0	0.1	3.1	0.3	1.4	1.4	...	20.4
Nova Scotia	17.0	3.9	0.3	11.1	3.8	1.7	0.3	0.1	38.2
New Brunswick	18.0	3.5	0.1	8.5	0.9	1.7	0.7	0.1	33.5
Total	47.1	9.4	0.5	22.7	5.0	4.8	2.4	0.2	92.1
Central									
Quebec	124.3	32.7	1.1	83.9	7.1	13.6	1.3	5.0†	269.1
Ontario	209.2	63.8	1.0	109.2	17.7	40.6	0.7	11.2‡	453.4
Total	333.5	96.5	2.1	193.1	24.8	54.2	2.0	16.2	722.4
Prairie									
Manitoba	70.5	12.1	0.1	15.8	1.3	7.3	0.3	0.9	108.3
Saskatchewan	226.7	20.7	0.2	21.8	2.3	11.2	0.1	0.2	283.2
Alberta	171.6	25.7	0.5	16.8	1.6	9.6	0.3	0.2	226.3
Total	468.8	58.5	0.8	54.4	5.2	28.1	0.7	1.3	617.8
Pacific									
British Columbia	17.7	5.9	0.1	8.7	8.7	7.4	0.2	0.2	48.9
Dominion Total	867.1	170.3	3.5	278.9	43.7	94.5	5.3	17.9	1481.2

*Based on Table 1 of the Monthly Bulletin of Agricultural Statistics, March 1932, pp. 59-61.

†Maple products 3.4; tobacco 0.9; honey 0.5; clover and grass seed 0.2.

‡Maple products 1.6; tobacco 6.3; honey 1.0; clover and grass seed 1.9; flax fibre 0.4.

In the maritimes, which obtained 6.2% of the gross receipts from Dominion farms, the bulk of the revenue comes from field crops, but the agriculture is diversified and receipts from sales of dairy products, animals, poultry and eggs, and fruits and vegetables are considerable.

The farmers of the central provinces obtained 48.8% of the gross receipts from Dominion farms, of which 46.2% came from crops, 26.7% from dairying, 13.4% from the sales of farm animals, 7.5% from poultry and 3.4% from fruits and vegetables.

The farmers of the prairies secured 41.7% of the gross receipts from Dominion farm sales, of which about 76% came from field crops, 9.5% from sales of animals, 8.8% from dairy products, and 4.6% from poultry.

To British Columbia agriculture went 3.3% of the agricultural revenue of the Dominion. Of this province's receipts from agriculture, field crops brought 36.2%; dairy products and fruits and vegetables each brought 17.8%; poultry and eggs brought 15.1%; and sales of farm animals 12.1%.

In Table 3 the areas of the principal field crops of each province and region in 1932 have been presented to supplement the information given in Table 2.

The total area of the crops of the prairies was equal to over 70% of the area of all crops of the Dominion in 1932.

Further statistics of Canadian agriculture by provinces and regions are arranged in Table 4.

In 1931, in the maritime and the prairie provinces, over 60% of the total population was rural, and over 43% of that of British Columbia. In the central provinces, the rural population was 38% of the total.



A grain field in Eastern Canada.

TABLE 3.—*Areas of the principal field crops of Canada, 1932, in thousands of acres.**

Provinces	Wheat	Oats	Barley	Rye	Buckwheat	Flaxseed	Mixed grains	Peas and beans	Potatoes and roots	Alfalfa, clover, hays, etc.	Corn	Total area of crops
Maritime												
Prince Edward Island	23.3	149.5	4.0	...	2.6	...	23.8	...	46.4*	226.3	0.3	476.2
Nova Scotia	3.3	85.1	7.9	...	4.1	...	4.8	...	30.1	400.2	0.5	536.0
New Brunswick	11.3	216.5	12.0	...	42.1	...	4.3	1.0	58.5	561.2	0.6	907.5
Total	37.9	451.1	23.9	...	48.8	...	32.9	1.0	135.0	1187.7	1.4	1919.7
Central												
Quebec	52.0	1785.5	114.3	6.2	116.9	1.4	99.0	21.5	165.8	3468.5	51.0	5832.1
Ontario	636.0	2338.0	456.0	57.5	197.0	6.3	986.0	121.5	289.0	3722.0	415.0	9224.3
Total	688.0	4073.5	570.3	63.7	313.9	7.7	1085.0	143.0	454.8	7190.5	466.0	15056.4
Prairie												
Manitoba	2651.0	1463.5	1123.3	40.6	5.7	49.3	17.0	2.0	36.8	464.2	13.4	5866.8
Saskatchewan	15543.0	4364.7	1329.5	482.5	...	381.2	20.8	0.6	46.1	159.4	6.1	22333.9
Alberta	8201.0	2704.8	701.3	183.1	...	15.2	25.3	0.9	44.8	2138.1	4.5	14019.0
Total	26395.0	8533.0	3154.1	706.2	5.7	445.7	63.1	3.5	127.7	2761.7	24.0	42219.7
Pacific												
British Columbia	61.2	90.8	9.3	3.9	...	0.3	3.0	3.9	23.8	237.3	4.2	437.7
Dominion Total	27182.1	13148.4	3757.6	773.8	368.4	453.7	1184.0	151.4	741.3	11377.2	495.6	59633.5

*Based on Tables I and III Monthly Bulletin of Agricultural Statistics, Ottawa, January 1933, pp. 6-13.

TABLE 4.—*Statistics of Canadian agriculture.**

	Per cent of population rural	No. of farms (000's)	Non-owning operators per cent of total	Value of land, and buildings per farm \$	Total area per farm. Acres	Improved area per farm. Acres	Pasture and un- improved land per farm. Acres	Crops per farm. Acres	Horses per farm	Cattle per farm	Sheep per farm	Hogs per farm
Maritime												
Prince Edward Island	76.8	12.9	1.8	3336	93	60	33	37	2.3	7.8	6	3
Nova Scotia	54.8	39.4	2.7	2092	109	21	88	14	1.1	5.6	5	1
New Brunswick	68.4	34.0	2.7	2265	122	39	83	27	1.5	6.3	4	2
Average	62.2	86.3	2.6	2345	112	34	78	22	1.4	6.2	5	2
Central												
Quebec	36.9	136.0	3.7	4989	131	66	65	43	2.2	12.6	5	5
Ontario	38.9	192.2	11.2	5539	119	69	50	48	3.0	13.1	5	7
Average	38.0	328.2	8.1	5311	124	68	56	46	2.7	12.9	5	6
Prairie												
Manitoba	54.9	54.2	18.1	5326	279	157	122	108	6.0	12.4	4	7
Saskatchewan	68.4	136.5	15.4	7365	408	246	162	164	7.3	8.7	2	7
Alberta	61.9	97.4	12.1	6802	400	182	218	144	7.5	11.7	8	11.
Average	62.4	288.1	14.8	6791	381	208	173	146	7.1	10.4	4	8
Pacific												
British Columbia	43.1	26.1	10.9	5544	136	27	109	17	2.1	9.4	6	2
Dominion Average	46.3	728.7	10.2	5553	224	118	106	82	4.3	11.0	5	6

*Based on Census of 1931. Preliminary report.

V. GENERAL SUMMARY OF THE AGRICULTURE OF CANADA BY REGIONS

A. Maritime Provinces.

Within the maritime provinces the climate is temperate, with the ample precipitation rather lighter in the summer months than during the remainder of the year. The growing season is fairly long, starting moderately late in the spring, but usually keeping free from fall frosts until danger of damage to crops from this source is over.

The farms are small having about 112 acres per farm, and requiring comparatively little capital. The percentage of tenants is low. There were 22 acres of crops per farm in 1931. At that time there were less than two horses per farm available for farm work. A few cattle and other stock were kept per farm.

The maritime area favors dairying, and the production of potatoes, and apples and other fruits, much of which finds its way to the markets of Great Britain. The Annapolis valley of Nova Scotia is one of the most famous fruit producing areas of Canada.

On Prince Edward Island about 40% of the occupied farm land was in field crops in 1931. Here a specialised agricultural industry has developed for the production of certified seed potatoes, most of which go to the United States.

A greater percentage of the potential farm lands of the maritimes is in farms than is found in any other region of Canada. Based on the 1931 census the values of the occupied farm lands including buildings, average about \$21 per acre.

In much of this area, the provision of field drainage is necessary. The application to cropland of barnyard manures and artificial fertilizers is the common practice, and occasional treatments with limes and soil correctives are considered advisable in many sections.

B. Central Provinces.

The lowlands of the St. Lawrence, on which are located most of the agricultural areas of the provinces of Quebec and Ontario, are favored with a temperate climate, and generally with abundant precipitation fairly evenly distributed throughout the year.

The proximity to large bodies of water retards the opening of spring, and also the approach of frosts and winter. Being located generally near to the densest centres of population in Canada, local conditions have considerable influence in determining the type of agriculture.

Natural and economic conditions favor dairying in a greater degree in this region than in any other Canadian area. From 1927 to 1931, an average of 26% of the farm income of these provinces came from the sales of dairy products.

Many varieties of crops are grown readily in this region. The temperate climate and abundant rainfall of many sections produce good pastures and good hay crops. About one-half of the cropland is usually used for hay, which is left down for several years. Corn, mostly for fodder and silage

purposes, and roots, have about equal acreages, and together occupied 6% of the cropland in 1932. These crops are primarily used for feeding dairy cattle.

Small grains are usually included in the rotation, frequently for two or more years. Manures are generally applied on the grass lands before plowing the sod. Purchases of commercial fertilizers are general. Lime applications, and similar soil correctives are used in some areas. The provision of field tile drains is necessary through much of this region.

Around favored areas, specialized fruit growing businesses have been developed. The Niagara district of Ontario produces excellent apples, peaches, grapes, and many other kinds of fruits favored by the temperate conditions of that area.

A very choice flue-cured tobacco is successfully grown in Norfolk county, Ontario. Other tobaccos are grown more generally in many sections of Quebec and Ontario.

As a general rule, the farms of the central provinces are somewhat larger than those of the maritimes. The census of 1931 indicated the average capital per farm to be \$5,311, and the crop area per farm, 46 acres. In 1931, the average amount of farm livestock consisted of 3 horses, 13 cattle, 5 sheep and 6 hogs. At that time, the farm lands, with buildings and other improvements had an average value of \$43 per acre, but the range in land values is very great. The fruit lands of Ontario have from two to three times the value of the general farm lands.

Approximately 40% of the potential farm lands of Quebec and Ontario were in farms in 1931 (Table 1).

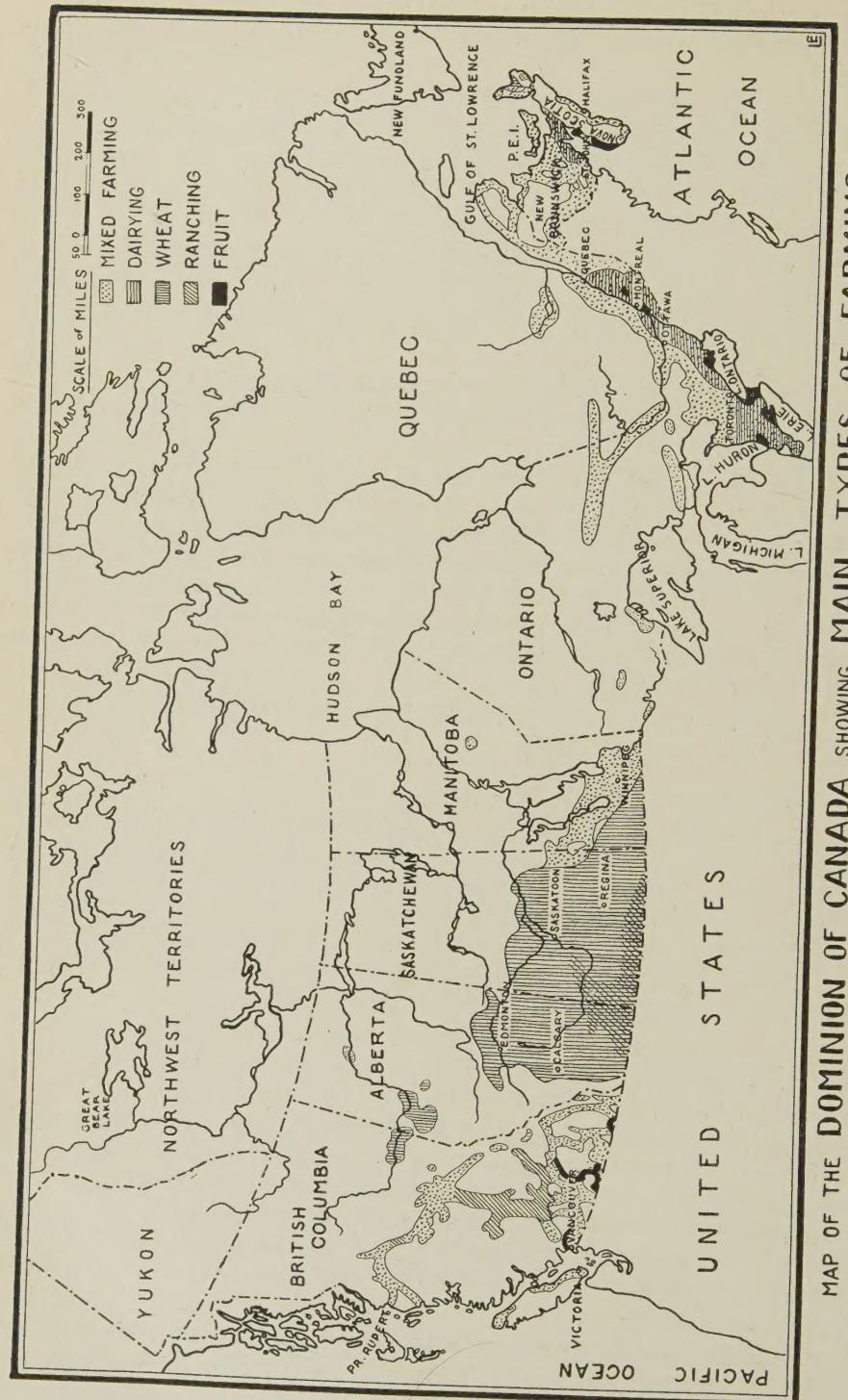
C. Prairie Provinces.

The farm lands of the prairies are primarily used for grain production, with most of the operations centred on wheat. The soils of these areas are generally quite fertile. The climate is more extreme than in the other agricultural areas of Canada. Rainfall is limited, in few areas being as much as 20 inches per year, and more generally less than 16 inches per year. The precipitation is usually well distributed during the growing season, but damage from droughts and hot winds is not infrequent.

The frost-free period is fairly short. In the summer, days are usually hot, and nights cool, favoring the production of high grade hard spring wheat, the major product of the farms of the area.

About 62% of the area producing field crops in 1932 was used for wheat production. Oats were grown on about 20% of the producing acreage, and barley on about 7%. The percentage of land used for crops for hay is small being only 6.5% of the total crop area. About two-thirds of this hay was obtained from grain cut in Alberta for that purpose, or for weed control. Pastures, natural or planted, are generally poor when contrasted with those of more humid areas.

To grow a crop of wheat successfully on the prairie plains it is necessary to conserve moisture and to control weeds. The system of farming generally followed throughout this region is to leave the land uncropped for a year,



MAP OF THE DOMINION OF CANADA SHOWING MAIN TYPES OF FARMING

and to plow and work the land sufficiently to keep down the weeds and to retain the moisture. This is generally known as the summer-fallow system. In most of the great plains areas the rotations provide for a year of summer-fallow followed by one or two crops of wheat, and one crop of oats or barley. Certain areas have adopted shorter rotations and summer-fallow one half of the land each year.

Barn yard manures are seldom used on the cropland. Chemical fertilizers are being experimented with quite widely and a limited demand for such supplies is developing (1933).

Throughout the grain areas, the farms are much larger than in any other region in Canada. Since 1921, farms have decreased in number and increased in size, and the use of expensive machinery of large calibre has increased considerably. Tractor operation of fields has reduced the number of work horses and the number of farm hands required. In certain sections the use of the combined harvester-thresher has partially displaced the binder-thresher method at harvesting. Capital requirements are high on these farms because of the large numbers of acres operated and the heavy investments in expensive machinery and implements. With this type of farming credit transactions were common, and extensive, and protracted. The severe depression in agriculture has made financing particularly difficult for prairie farmers.

Land values, including buildings and other improvements, were estimated at about \$18 per acre in 1931. The average stock per farm for the prairies consisted of 7 horses, 10 cattle, 4 sheep and 8 hogs. There are many farms on which the animals are limited to the horses required for field work, and the cattle, hogs and poultry for farm family needs. Range operations of livestock are of considerable importance in south western Saskatchewan and portions of southern Alberta. A limited number of farms are operated entirely with mechanical power, but the bulk of the field work is done with horses.

D. Pacific Province.

The agriculture of British Columbia is generally divided between the mountain valleys and the coastal plains. The climate is particularly mild where influenced by the Pacific breezes. Rainfall is generally abundant, decreasing with the distance from the ocean and the proximity to the mountains. The summer months generally have the lightest rainfall.

In certain sections near to the largest cities, e. g. the Lower Fraser valley, fairly specialized dairy farming predominates. Other valleys, such as the Okanagan and Kootenay valleys, are favored for the production of many varieties of high grade fruits and vegetables, much of which is marketed on the prairie plains. Fruit growing in these interior valleys is dependent on irrigation from mountain streams.

The poultry industry has made much progress in the Pacific province in which conditions seem to be particularly favorable. A number of extensive cattle ranches, and sheep ranges are located in the hilly areas of the province which effectively utilize some lands not suitable for other types of agriculture. These lands are leased from the government at a low rate per acre, for comparatively long terms.

The coastal cities have developed into popular residential and holiday centres, and draw largely from the prairies. In prosperous times, many who are able to do so leave the prairie to reside at the coast during the winter months when prairie farm work is slack.

The average area of the many different types of farms of the Pacific province is about 136 acres, of which only 27 acres are improved, and of which only 17 acres per farm are in field crops. From 2 to 3 horses per farm are kept for field work, and about 9 cattle, 6 sheep and 2 hogs. The lands vary considerably in value, depending on the character of the enterprises favored. The general average of all British Columbia farm lands with buildings and improvements was \$41 per acre in 1931, with the fruit lands some 4 or 5 times this value. In this province only about one-seventh of the potential farm land had been brought into farm use in 1931. There has been considerable development of farms in the lower mainland during recent years.

VI. CONCLUSION

With the exception of the maritime and central provinces there is little uniformity or continuity of agricultural areas as may be seen from the accompanying map of the Dominion of Canada showing the main types of farming. In most cases the agriculture of the Canadian areas resembles fairly closely that of the areas of the states adjoining them, of which they are naturally a part. The tremendous geographical obstacles between the areas increase the difficulties of communication, transportation, and distribution. The people of the different sections find it difficult to understand each other's problems, both in agriculture and industry generally. Recent depressions have made the problems of each area more acute, and have tended to confine and concentrate the attention of the farmers of each area on their own problems. The barriers between the agricultural and general Canadian economic regions retard the general movement of commodities. Most Canadian agricultural areas produce more than is needed locally, and the surpluses resulting have to be disposed of in outside markets, where they encounter heavy competition, and meet serious political and economic obstacles.

THE TYPE OF INFECTION OF WHEAT SEEDLINGS BY *PUCCINIA GRAMINIS TRITICI* IN THE GREENHOUSE AS A MEASURE OF THE PERCENTAGE INFECTION IN THE FIELD¹

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INTRODUCTION

The extent to which the reactions of wheat varieties and strains to stem rust, as determined by their seedling reactions in the greenhouse, may be considered a measure of their resistance in the field is of considerable importance. Greenhouse tests can be made much more economically than field tests, and if the seedling reaction of a variety or strain can be considered a criterion of its reaction in the field, there is an obvious advantage in making the tests in the greenhouse. Performance under field conditions must, of course, be the final test of any one variety. If, however, in breeding experiments involving a thousand or more lines, preliminary eliminations could be based on seedling reactions in the greenhouse, a considerable saving of time and labour would be effected. The experimental results recorded here are concerned with this phase of the problem of breeding for rust resistance.

Investigations conducted in the Plant Breeding Department of the Minnesota Agricultural Experiment Station, (4, 5) indicated that certain wheat strains were moderately resistant to stem rust in the field, in spite of being susceptible to certain physiologic forms of *Puccinia graminis tritici* in the greenhouse. Harrington (3) concludes from a study of ten plants each of the crosses Mindum × Pentad and Kubanka × Pentad that there is "a complete lack of correlation between either resistance or susceptibility in the field and the reaction of the hybrids to form 21 in the greenhouse" (p. 285).

It has been demonstrated at this laboratory (1, 2, 6) that the field reaction of the varieties H-44-24 (Marquis × Emmer) and Pentad is mainly controlled by genetic factors independent of those concerned in the reaction of seedlings in the greenhouse. In crosses between H-44-24 or Pentad and susceptible varieties, the main field reaction is inherited in a relatively simple manner, and independently of the seedling reaction in the greenhouse. Minor differences in the field reaction of lines derived from these crosses may be correlated with seedling reactions in the greenhouse. Experimental results bearing on this question are, so far, inconclusive. It is evident from these results that for breeding purposes the seedling reactions in the greenhouse are practically worthless as far as crosses involving H-44-24 and Pentad are concerned.

The relation between the seedling reaction in the greenhouse and the field reaction in the cross Garnet × Double Cross has been studied by the author, and a preliminary report published (6). It is stated that "there is practically no evidence of the operation of any factors in addition to those

¹Contribution from the Cereal Division, Experimental Farms Branch, Department of Agriculture, Ottawa.

²Cereal Specialist.

identified with the seedling reaction in the greenhouse". Due to the inadequacy of field data, the results were not considered conclusive. In the same report, results of a study of the cross Marquillo \times H-44-24 are given. In this case the factors controlling the seedling reaction in the greenhouse were found to have a marked effect on the field reaction. In view of these results it seemed worth while to study further the relation between greenhouse and field reactions in crosses involving Marquillo and Double Cross.

METHODS

Except in the cross Garnet \times Double Cross, where several forms were used, all greenhouse studies were made with pure cultures of physiologic form 21 of *Puccinia graminis tritici*. The author is indebted to Mr. A. M. Brown of the Division of Botany for supplying the cultures. Seedlings were classified as follows: R (highly resistant), MR (moderately resistant), SR (semi-resistant), MS (moderately susceptible), and S (susceptible). For the purpose of calculating mean values of F_1 lines the numbers 1 to 5 were substituted for the above symbols. In the field all plants were classified according to percentage infection. The field infection was due to both natural and artificially induced epidemics. About thirty physiologic forms were included in the production of the artificial epidemics.

During the entire course of the study the lines of wheat were recorded by number, and greenhouse classifications were made without knowledge of field reactions, and vice versa.

RESULTS

Parental Varieties.

The three crosses discussed in this report are Marquillo \times Reward, Garnet \times Marquillo, and Garnet \times Double Cross. The varieties Marquillo and Double Cross were developed at the Minnesota Agricultural Experiment Station (5). The former was selected from the cross Marquis \times Iumillo, and the latter from the cross (Marquis-Iumillo) \times (Marquis-Kanred). Reward and Garnet, both susceptible to stem rust under field conditions, were originated at the Central Experimental Farm, Ottawa. The durum variety Iumillo is the only wheat that has been entirely immune to stem rust under field and greenhouse conditions at this laboratory, and Marquillo inherits a moderate degree of resistance from this variety. The three strains of Double Cross tested are slightly more resistant in the field than is Marquillo and it is possible that the higher resistance of the Double Cross strains is due to the immunity to several physiologic forms inherited from Kanred. The data given in Table 1 are taken from the rust nursery trials conducted at this laboratory. These data are presented largely to illustrate the striking irregularity in the reactions of Marquillo and the Double Cross strains. The two strains of Marquillo were obtained from different sources, but are probably identical. It is clear from the figures given for susceptible varieties that the epidemics were severe each year, and yet Marquillo fluctuated from year to year from 5 to 50%. A similar fluctuation—regional instead of annual—is illustrated by the data given by Hayes *et al* (5, table 3). For example, in 1924 at Waseca, Marquis was scored 80%, and Marquillo (Marquis \times Iumillo II-15-44) 1%. At Grand Rapids, in the same year, Marquis was rated 87%,

and Marquillo 42%. These results might be attributed to the relative abundance of certain physiologic forms. However, at Winnipeg the epidemic involves many forms, and for the most part the same forms are used each year. Furthermore, the reaction of Marquillo fluctuates from plant to plant. In the plots of Marquillo accompanying the hybrid material in 1932, the reaction of individual plants fluctuated from 10 to 60%, apart from occasional obvious admixtures. The author can offer no explanation for this peculiar type of reaction, but it would appear that only under optimum conditions can an infection of 50 or 60% be obtained. It is evident from the data in Table 1 that the reactions of the Double Cross strains fluctuate in a similar manner.

TABLE 1.—*The reaction of several wheat varieties to stem rust in the field.*

Variety	R.L. No.	1926	1928	1929	1930	1931	1932	Mean	Mean (1928- 1932)
Iumillo	7	0	0	0	0	0	0	0	
Garnet	15	85	75	85	80	60	80	77.5	
Marquis	96	90	70	85	90	85	80	83.3	
Marquillo	59	5	35	10	50	5	50	25.8	30.0
Kota	76	70	45	65	75	70	65	65.0	
Reward	79	80	70	75	80	85	75	77.5	
Ceres	127	75	45	70	85	75	75	70.8	
Marquillo	132	5	25	20	40	15	45	25.0	29.0
Renfrew	135	90	65	85	85	90	85	83.3	
Hope	209	tr	0	1-5	0	tr	0		
H-44-24	229	tr	tr	1-5	0	tr	0		
Pentad	203	10	tr-5	15	20	tr	tr		
Double Cross 825-2	379		35	5	45	25	15		25.0
Double Cross 825-4	380		30	5	55	15	15		24.0
Double Cross 806-6	381		30	10	45	25	15		25.0

Marquillo × Reward.

This cross was made in the year 1926. In 1931 an F_2 population was grown from reserve seed, and exposed to an artificial epidemic of stem rust in the field. In all, 970 plants were classified according to percentage infection. The results of this classification are given in Table 2. For the study of F_3 lines the F_2 60, 70, and 80% classes were reduced to 75 lines each. In the other classes all F_2 plants were used, giving a total of 391 lines for the F_3 studies. In the correlation studies the number of lines will be found to vary from 365 to 388. This is accounted for by the fact that lines giving less than five infected seedlings in the greenhouse, or less than ten infected plants in the field are not included.

TABLE 2.—*The distribution of F_2 plants of three crosses according to stem rust infection in the field in 1931.*

Cross	Stem Rust %										
	0	10	20	30	40	50	60	70	80	90	Mean
Iumillo × Mindum	62	84	41	51	62	80	146	189	68	8	47.8
Marquillo × Reward	5	18	29	40	64	186	397	221	10	65.6	
Garnet × Marquillo	1	5	5	16	29	158	502	282	10	69.9	

The F_3 lines were inoculated in the greenhouse during the winter of 1931-32 with form 21 of *Puccinia graminis tritici*. The mean and standard error of the type of infection was calculated for each line. In the greenhouse tests one pot of each of the parental varieties was included in each batch (about 80 lines) of hybrid material. Reward gave a uniformly susceptible reaction, and Marquillo was highly resistant, though seedlings with varying degrees of susceptibility were not uncommon. Surplus seed of the same lines was planted in the field in 1932, and exposed to an artificially induced epidemic of stem rust. The mean and standard error of the percentage infection was calculated for each line. Eleven plots each of Reward and Marquillo accompanied this cross in the field. The mean percentage infection of the former was 79.1, and of the latter 42.2.

The relationship between the F_2 (1931) and F_3 (1932) field reactions is shown in Table 3. The agreement is remarkably close, and indicates that the field classification of F_2 plants is fairly accurate. The coefficient of correlation calculated from this table is .795.

TABLE 3.—*The relationship between F_2 and F_3 field reactions in the cross Marquillo × Reward*

F_3 (means) — Stem Rust %	F ₂ Stem Rust %									
	10	20	30	40	50	60	70	80	90	
40	1									
45	1									
50	2	3	1							
55		3	11	3	2					
60	1	3	6	10	4	1				
65		5	8	14	9	4	2			
70		3	3	10	18	9	7			
75		1		2	13	25	16	2		
80				1	15	29	38	27	2	
85					2	6	9	27	5	
90						1	1	2		

The extent to which the field reaction of F_2 plants is associated with the greenhouse seedling reaction of their progeny (F_3) to form 21 is shown in Table 4. The high correlation ($r = .812$) suggests that the type of infection produced by form 21 in the greenhouse is controlled by the same genetic factors which govern the inheritance of the field reaction, as measured by percentage infection. The two lines in the upper right hand corner of the table proved moderately susceptible in the field in F_3 , one giving a mean of 63.5, and the other of 73.5%. There is, therefore, no indication of the inheritance of the field reaction being materially affected by any factors other than those concerned in the inheritance of the reaction of seedlings to form 21 in the greenhouse.

As stated in an earlier section, the seed from each F_2 plant was divided into two lots, one for greenhouse and one for field tests. The figures in Table 5 show the degree of relationship between the greenhouse and field means ($r = .761$). It will be observed that the association is rather close, and indicates that the inheritance of the field reaction in this cross is mainly, if not entirely, controlled by the factors which govern the inheritance of the seedling reaction to form 21 in the greenhouse. It will be observed that the greenhouse reaction (F_3) is more closely correlated with the F_2 than with

TABLE 4.—*The relationship between the field reaction of F_2 plants and the greenhouse seedling reaction to form 21 of their progeny (F_3), in the cross Marquillo \times Reward.*

F_2 Stem Rust %	Greenhouse Reaction (F_3 means)								
	1.00*	1.01—1.50	1.51—2.00	2.01—2.50	2.51—3.00	3.01—3.50	3.51—4.00	4.01—4.50	4.51—5.00
10	2								
20	1	9	5	1					
30	3	9	9	2					
40	5	10	13	3	3				
50	10	13	9	16	10				
60				8	14	7	3	4	
70					5	31	11	11	
80					5	23	26	20	
90					5	12	22	36	
						1		9	

*1.00 = R, 2.00 = MR, 3.00 = SR, 4.00 = MS, 5.00 = S.

the F_3 field reaction. This is probably due to the heavier epidemic of 1932, when the F_3 field reactions were determined. In both 1931 and 1932 the epidemic was sufficiently severe to produce a maximum infection on susceptible plants. However, in 1931, with a somewhat lighter epidemic, the difference between the reaction of Marquillo and susceptible varieties was much more clear cut than in 1932 (see Table 1). The reduced spread between field resistant and field susceptible classes probably accounts for the slightly lower correlation between the F_3 field and F_3 greenhouse, than between the F_2 field and F_3 greenhouse reactions.

TABLE 5.—*The relationship between the greenhouse reaction (F_3 means) and the field reaction (F_3 means) in the cross Marquillo \times Reward.*

Field Reaction (F_3 means)	Greenhouse Reaction (F_3 means)								
	1.00*	1.01—1.50	1.51—2.00	2.01—2.50	2.51—3.00	3.01—3.50	3.51—4.00	4.01—4.50	4.51—5.00
40									
45									
50	1	1	1	1		1			
55	3	10	6	1	1	2			
60	4	6	7	2	1	1			
65	1	10	14	1	6	7	4		
70	2	3	10	6	11	7	5		
75			1	3	6	12	22	3	
80			1	4	6	11	29	9	
85					2	12	12	25	
90						1	12	25	
						3		7	

*1.00 = R, 2.00 = MR, 3.00 = SR, 4.00 = M.S. 5.00 = S.

If the field and greenhouse reactions are controlled by the same genetic factors, lines segregating for the reaction to form 21 in the greenhouse should also segregate in the field. The correlation between the standard errors

calculated for field and greenhouse reactions for each F_3 line should provide a check on the conclusions already drawn, from the comparison between field and greenhouse means. The correlation coefficient thus calculated is equal to .287. It is questionable whether this result can be considered to confirm the conclusion that the inheritance of the reaction to stem rust in the field is controlled by the same genetic factors as is the reaction to form 21 in the greenhouse. However, consideration of the following facts will show that a high correlation between the standard errors calculated from F_3 field and F_3 greenhouse reactions could not be expected.

TABLE 6.—*The relationship between the means and standard errors of individual F_3 lines (field reaction) in the cross Marquillo \times Reward.*

Standard Errors	Means										
	40	45	50	55	60	65	70	75	80	85	90
1								17			
2								2	3		
3								6	6		
4								11	13	1	
5								5		14	2
6						2		7	25		7
7						4	3	12	7		
8						5	10	13	13	6	
9						3	11	13	10		1
10						6	4	4	1		
11						3	2	3			
12						2	1	1	6	1	
13						1	1	4			
14						1	1	2			
15							1		1		
16						2	1	2		1	
17							2	1			
18							1				
19											

The variability of the field reaction of Marquillo has already been stressed. In the Marquillo plots accompanying the hybrid material in this cross, apart from obvious mixtures, the infection of individual plants varied from 10 to 60%. The same variability was characteristic of the resistant F_3 lines. In the greenhouse, on the other hand, Marquillo is fairly constantly resistant to form 21. Eleven F_3 lines were homozygous for the high resistance of Marquillo to form 21, the standard errors, of course, being zero. The figures in Table 6 illustrate the relationship between the means and standard errors of the field reaction of F_3 lines ($r = -.569$). It is clear from these facts that

TABLE 7.—*The relationship between the means and standard errors of individual F_3 lines (field reaction) in the cross Marquillo \times Reward.*

Means	Standard Errors																			Mean
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
40-60									1	5	5	9	9	6	4	5	2	1	5	10.1
65-75									7	14	29	28	27	14	7	8	2	5	3	8.3
80-90	17	5	13	25	35	32	19	11	/	2	3	1						1		5.0

TABLE 8.—Relationship between standard errors of greenhouse reactions (F_3) and field reaction means (F_3) in the cross Marquillo \times Reward.

		Greenhouse Reaction (Standard Error)																				
		.10	.20	.30	.40	.50	.60	.70	.80	.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	Mean
Field Reaction																						.55
40-60	10	1	3	5	13	2	4	1	6		2	1										.70
65-75	11		4	8	32	25	16	13	14	11	3	6	3	1								
80-90	37	1	5	7	33	24	18	15	6	6	4	2	2	1								.54
(F_3 Means)																						

a high correlation between the standard errors of field and greenhouse reactions is impossible. All lines presumably homozygous for the field resistance of Marquillo are so variable that they give a high standard error while the same lines tend to give a low standard error in the greenhouse. An examination of Tables 7 and 8 will make this point more clear. Table 7 contains the same data as Table 6, only the number of classes for the field reaction is reduced to three. The tendency for the field resistant lines to have a high standard error is quite pronounced. The data in Table 8 illustrate the relationship between the field reaction means and the standard errors of the seedling reactions to form 21 in the greenhouse. In this case it is evident that the lines resistant in the field are no more variable in the greenhouse than are the field susceptible lines, the average standard error being 0.55 for the former and 0.54 for the latter. It is evident, therefore, that the seedling reaction in the greenhouse, of lines which inherit Marquillo resistance, is relatively constant, while the field reaction is subject to considerable variation.

The various relationships in this cross as determined by the correlation coefficient are summarized in Table 9. It will be observed that the correlation between the means and standard errors of F_3 lines for the greenhouse reaction to form 21 is quite insignificant, an interesting contrast with the results for the field reaction.

It should be emphasized that the magnitude of the correlation coefficients obtained between field and greenhouse reactions is not enough in itself to justify the conclusion that Marquillo has no "mature plant" resistance. The main feature of the results is that no lines were obtained with a high degree of resistance in the field, which were not also resistant in the seedling stage to form 21 in the greenhouse; and conversely, that all lines resistant to form 21 in the greenhouse were resistant under field conditions.

Garnet \times Marquillo.

In this cross the same procedure was followed as in the case of Marquillo \times Reward. The distribution of F_2 plants according to the field reaction is given in Table 2. It will be observed

that there is a much lower proportion of plants in the resistant classes than is the case with Marquillo \times Reward (see also Neatby and Goulden (7)). The F_2 60, 70, and 80% classes were reduced to 100 plants each for the F_3 studies.

Only a summary of the results obtained in this cross will be given. But for the fact that all relationships are rather less close, the results are similar to those obtained in the Marquillo \times Reward cross (see Table 10), and tend to confirm the conclusion already drawn, regarding the inheritance of Marquillo resistance. That numerous genetic factors are involved in this cross is indicated by the fact that not one line bred true for the seedling reaction of Marquillo to form 21. Of 333 lines for which field means were determined

TABLE 9.—*Summary of relationships in the cross Marquillo \times Reward.*

Characters	$P = .01$			
	r	t	$t =$	n'
F_2 field reaction and F_3 field reaction (means)	.7954	25.11	2.58	368
F_2 field reaction and F_3 greenhouse reaction (means)	.8116	27.36	2.58	388
F_3 field reaction (means) and F_3 field reaction (S.E.)*	-.5689	13.23	2.58	368
F_3 field reaction (means) and F_3 greenhouse reaction (means)	.7613	22.37	2.58	365
F_3 field reaction (S.E.) and F_3 greenhouse reaction (S.E.)	.2870	5.71	2.58	365
F_3 greenhouse reaction (means) and F_3 greenhouse reaction (S.E.)	.0553	1.09	2.58	388

*Standard Errors.

only five had a mean value of 55% or less. In Marquillo \times Reward, 27 lines of the 368 determined had a mean value of 55% or less. The lower correlations between field and greenhouse reactions in Garnet \times Marquillo than in Marquillo \times Reward is probably accounted for by a low degree of correlation in the "susceptible" ends of the distributions—where most of the variates are heaped.

In Table 2, the distribution of F_2 plants according to the field reaction to stem rust is given for the cross Iumillo \times Mindum. It appears from the nature of the distribution that the field reaction to stem rust is relatively simply inherited, as far as this intra-durum cross is concerned. Marquillo

TABLE 10.—*Summary of relationships in the cross Garnet \times Marquillo.*

Characters	$P = .01$			
	r	t	$t =$	n'
F_2 field reaction and F_3 field reaction (means)	.5969	13.54	2.58	333
F_2 field reaction and F_3 greenhouse reaction (means)	.6353	15.65	2.58	362
F_3 field reaction (means) and F_3 field reaction (S.E.)*	-.4827	10.03	2.58	333
F_3 field reaction (means) and F_3 greenhouse reaction (means)	.4946	10.32	2.58	331
F_3 field reaction (S.E.) and F_3 greenhouse reaction (S.E.)	.1658	3.04	2.58	330
F_3 greenhouse reaction (means) and F_3 greenhouse reaction (S.E.)	-.1026	1.96	2.58	362

*Standard Errors.

inherits only a small part of the resistance of Iumillo, judging from both field and greenhouse reactions, yet the inheritance of Marquillo resistance in intra-vulgare crosses is very complicated. Detailed results of field and greenhouse studies in the cross Iumillo \times Mindum will be published at an early date.

Garnet \times Double Cross.

A comparative study of field and greenhouse reactions in this cross was made in 1930 (6). Since the 1930 field data were incomplete, the same lines (F_5) were subjected to field epidemics in 1931 and 1932. The rust percentages were estimated by the author in 1931, and by Mr. R. F. Peterson in 1932. The correlation coefficient calculated for the two readings is $.711 \pm .033$. For comparison with greenhouse reactions, averages of the two field determinations are used.

Eleven physiologic forms were used in the greenhouse study of Garnet \times Double Cross, the results of which have already been published in detail (6). The immunity of Kanred was involved in eight of the eleven forms used, but this immunity seemed to have very little to do with the field reaction. It was suggested that the presence of the Kanred immunity factor might increase the field resistance of lines carrying more important field resistance factors.

TABLE 11.—*Relation between the immunity of seedlings to certain physiologic forms and the field reaction (1931-1932) in the cross Garnet \times Double Cross.*

	Field Reaction (%)									Mean
	20	30	40	50	60	70	80	90		
Immune	1	3	2	1	4	10	19	8	71.2	
Not Immune		1	2	3	3	5	30	7	74.9	

A comparison between the field reactions of lines bearing the immunity factor with those lacking it is made in Table 11. The mean percentage field infection of lines lacking the immunity factor is slightly greater than the mean of lines possessing that factor; the difference, however, is not great. Whether the difference between the field reactions of Marquillo and the Double Cross strains (see Table 1) can be accounted for by the immunity of Double Cross to the physiologic forms to which Kanred is immune is, therefore, open to question.

TABLE 12.—*Relation between the seedling reaction to forms 33, 35 and 36 in the greenhouse and the field reaction (1931-1932) in the cross Garnet \times Double Cross.*

	Field Reaction (%)									Mean
	20	30	40	50	60	70	80	90		
R to all of 33, 35, 36	None obtained									
R to 2 of 33, 35, 36	1	3	2	3	3	8	15	4	67.7	
R to 1 of 33, 35, 36		1	3	1	4	8	17	5	72.0	
R to 0 of 33, 35, 36				1*		1	18	6	80.8	

*This line is SR to form 36.

In Table 12, the combined action of the factors which control the seedling reaction to forms 33, 35, and 36 on the field reaction is illustrated. Here there is a marked relationship. The correlation, however, is much closer when the seedling reaction to form 36 alone is compared with the field reaction (see Table 13). This is due to the fact that the factors which control the seedling reaction to forms 33 and 35 have very little effect on the field reaction.

It is clear from the data in Table 13 that the field reaction is in large measure controlled by the factors which govern the inheritance of the seedling reaction in the greenhouse to form 36. The encroachment of the greenhouse reaction R class on the field susceptible class is a result of the variability of Double Cross resistance under field conditions.

TABLE 13.—*Relation between the seedling reaction to form 36 in the greenhouse and the field reaction (1931-1932) in the cross Garnet × Double Cross.*

		Field Reaction (%)								
		20	30	40	50	60	70	80	90	Mean
R		2	2	3	4	5				55.0
Form 36	SR	1	2	3	2	3	8	23	2	69.5
	S					4	27	13	82.0	

In Garnet × Double Cross, as in the two Marquillo crosses already discussed, there is no doubt that the inheritance of field resistance to stem rust (under Winnipeg conditions at least) is controlled mainly, if not entirely, by the factors which govern the inheritance of the reaction of seedlings to certain physiologic forms in the greenhouse. In fact, the seedling reaction to form 21 alone is a thoroughly reliable basis for selection for field resistance in all of the three crosses under discussion. Except for the fact that the Kanred immunity factor is operative with form 21 in Garnet × Double Cross, reactions to forms 21 and 36 are controlled by the same genetic factors (see Neathy, Table 11 (6)). In the non-immune lines the relationship between the reactions to forms 21 and 36 is very close. This means that, in Garnet × Double Cross, lines with Kanred immunity to form 21 may or may not be resistant under field conditions; but lines with the resistance of Marquillo to form 21 will also be resistant to form 36 in the seedling stage, and will possess resistance under field conditions similar to that of Marquillo.

SUMMARY

Comparative studies of greenhouse seedling reactions and field reactions in the crosses Marquillo × Reward, Garnet × Marquillo, and Garnet × Double Cross have been made.

The results obtained in all three crosses indicate that the inheritance of the field reaction to stem rust, as determined by percentage infection, in these crosses is mainly if not entirely controlled by the factors which govern the inheritance of the seedling reaction to form 21 in the greenhouse, as determined by pustule type. In other words, there is no evidence of Marquillo or Double Cross possessing any "mature plant" resistance such as that identified (1, 2, 6) in connection with H-44-24 and Pentad.

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LITERATURE CITED

1. GOULDEN, C. H. Breeding rust resistant varieties of wheat—fundamental aspects of the problem. *Sci. Agric.* 10: 258-267. 1929.
2. ————— and K. W. NEATBY. Breeding rust resistant varieties of spring wheat. *Jour. Am. Soc. Agron.* 23: 859-870. 1931.
3. HARRINGTON, J. B. The inheritance of resistance to *Puccinia graminis* in crosses between varieties of durum wheat. *Sci. Agric.* 5: 265-288. 1925.
4. HAYES, H. K. and O. S. AAMODT. A study of rust resistance in a cross between Marquis and Kota wheats. *Jour. Agric. Res.* 24: 997-1012. 1923.
4. —————, E. C. STAKMAN and O. S. AAMODT. Inheritance in wheat of resistance to black stem rust. *Phytopath.* 15: 371-387. 1925.
6. NEATBY, K. W. Factor relations in wheat for resistance to groups of physiologic forms of *Puccinia graminis tritici*. *Sci. Agric.* 12: 130-154. 1931.
7. ————— and C. H. GOULDEN. II. The inheritance of resistance to *Puccinia graminis tritici* in crosses between varieties of *Triticum vulgare*. *Sci. Agric.* 10: 389-404. 1930.



Farm home of Anton Sware near Hay Lakes, Alta.

THE OVERWINTERING OF BUNT SPORES IN WESTERN CANADA¹

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Infection of wheat by bunt or stinking smut may result from soil borne spores, or from spores adhering to the surface of seed grain. In certain regions where winter wheat is grown, fall infection by soil borne spores is commonly met with. Under these conditions, seed which has been treated with fungicides, such as formalin or copper carbonate, may still produce a smutty crop.

In spring wheat areas an entirely different situation prevails. Many of the spores which remain in the field after fall threshing has been completed may germinate before the ground freezes. Those which fail to germinate in the fall are subjected, during the winter and early spring, to a process of freezing and thawing, and their viability is greatly reduced. Consequently, by the time spring wheat is sown, it is probable that the soil contains a relatively small number of viable bunt spores. The effectiveness of seed treatment in controlling bunt in spring wheat lends support to the view that bunt spores do not overwinter readily in the soil.

Appel and Riehm (1), in Germany, conducted experiments on the overwintering of bunt spores. In the fall of 1912 they filled cylinders with different types of soil, and into the top layer of soil in each cylinder they mixed bunt spores. The cylinders were left out of doors during the winter, and the following spring the spores were tested for germination. No germination was observed, and spring wheat sown in the soil remained free from bunt infection. Hahne (2) also states that bunt spores do not overwinter in the soil.

It is well known that wheat plants infected with bunt are frequently much shorter than healthy plants. In the process of harvesting, the heads of these stunted plants are likely to fall to the ground and remain there throughout the winter. It is probable also that numbers of bunted heads are scattered about in places where threshing machines have been set up. The spores in these heads are protected by the glumes and the outer covering of the bunt ball and, in regions where fall precipitation is low, they might be expected to pass the winter in a relatively dry condition. Resting cells with a low moisture content can frequently withstand very low temperatures without serious injury. Consequently, it is possible that, under certain conditions, bunt spores overwintering in infected heads on the surface of the ground may retain their viability until the spring.

In September 1931, heads of Mindum wheat infected with *Tilletia tritici* (Bjerk.) Wint. were sent to the Dominion Laboratories of Plant Pathology at Saskatoon, Sask., and Edmonton, Alta., and to the Dominion Experimental Farms at Morden, Man., Brandon, Man., and Indian Head, Sask. These infected heads had been collected at Winnipeg in 1931. At each station some of the heads were placed to overwinter on the surface of stubble land; others were buried about six inches below the surface. Bunted heads were also allowed to overwinter under similar conditions at Winnipeg, Man.

¹Contribution from the Division of Botany, Experimental Farms Branch, Department of Agriculture, Ottawa. Co-operative experiment made by the Dominion Rust Research Laboratory, Winnipeg, the Dominion Laboratories of Plant Pathology at Saskatoon and Edmonton, and the Dominion Experimental Farms at Morden, Brandon and Indian Head.

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In the spring of 1932, when wheat seeding had begun, the infected heads were gathered and sent to Winnipeg for tests of spore germination.

On examination, many of the heads showed signs of severe weathering, and some had been invaded by soil fungi. A number of the sound kernels in partially bunted heads had germinated. Most of the bunt balls were unbroken and the spores appeared to be uninjured.

Spores from a few of the bunt balls in each head were placed to germinate in petri dishes containing 1.5% non-nutritive agar. The results of the germination tests are summarized in Table 1. No attempt was made to count the percentage of spores germinating. The lots recorded as giving high germination appeared to germinate as freely as spores of the same collection which had been stored in the laboratory; low germination indicates that very few spores germinated; and medium germination indicates a condition intermediate between the two.

At all six stations a certain proportion of the spores which had overwintered in heads placed on the surface of the ground were capable of germinating. With one exception, that of Winnipeg, burying of the infected heads resulted in decreasing the viability of the spores, or rendering them incapable of germination.

TABLE 1.—*Germination tests of bunt spores overwintering in infected wheat heads in Western Canada.*

Station	Germination	
	Heads placed on surface of ground	Heads buried 6 inches
Winnipeg	low	medium
Indian Head	high	low
Edmonton	"	"
Brandon	medium	none
Morden	high	"
Saskatoon		

The results of the experiment indicate that, under certain conditions, bunt spores overwintering in infected heads retain their viability. They suggest also that, when wheat is to be seeded on land which produced a smutty crop the preceding year, the possibility of soil infection may be greatly reduced by fall plowing.

SUMMARY

Bunt spores (*Tilletia tritici*) in infected heads of Mindum wheat placed on the surface of the ground, overwintered successfully at the following stations: Winnipeg, Morden, Brandon, Indian Head, Saskatoon, and Edmonton.

With one exception, that of Winnipeg, spores overwintering in heads buried 6 inches in the ground were less viable than those overwintering on the surface, or failed to germinate.

BIBLIOGRAPHY

1. APPEL, O. and RIEHM, E. Zur Frage der Überwinterung des Steinbrandes im Boden. Arb. K. Biol. Anst. f. Land- und Forstw. 15: 6. 1914.
2. HAHNE, J. Untersuchungen über die Keimungsbedingungen von *Tilletiasporen*. Kühn-Arch. Arb. Landw. Inst. Univ. Halle 9. 1925. (Abs. in R.A.M. 5: 728. 1926.)

SOME SOIL MICROBIOLOGICAL ASPECTS OF PLANT PATHOLOGY¹

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In view of the results obtained recently in this laboratory relative to the action of other soil-inhabiting micro-organisms in modifying the virulence of the root-rotting pathogens *Ophiobolus graminis*, *Helminthosporium sativum* and *Fusarium* sp., I wish to discuss briefly, and in a general way, the bearing these results have on plant pathology.

For present purposes, the micro-organisms which cause plant diseases may be grouped roughly into two classes, viz., those which live normally in the soil and those which do not. Naturally a large number of plant pathogens cannot be classified so definitely. To the former group belong certain genera which cause the root-rots of cereals, forage and vegetable crops, and include *Fusarium*, *Helminthosporium*, *Ophiobolus*, *Leptosphaeria*, *Pythium*, *Ozonium*, *Phytophthora*, *Sclerotinia*, *Actinomyces*, *Rhizoctonia*, *Spongospora*, *Synchytrium*, *Thielavia* and certain species of bacteria.

Suffice it to say a very important, if not the most important, group of plant pathogens normally inhabits the soil, producing damage mainly on the underground parts of plants. Therefore, plant pathologists must understand their life in the soil, including their relations to other soil micro-flora and micro-fauna. It is in this connection that the plant pathologist becomes a soil micro-biologist.

The increase or decrease, and consequently the activity, of the micro-flora obviously depends largely on whether the environment is favourable or unfavourable. The amount and kind of food, the reaction of the soil, the temperature and content of moisture, and other stimulating or adverse substances are known to affect greatly the micro-flora (Waksman's "Principles of Soil Microbiology" chapters 21 and 29). We are told that when soil is kept at the same moisture and temperature for a considerable time the micro-organisms will reach a certain equilibrium, but this equilibrium is quite easily upset by some change in the chemical or physico-chemical condition of the soil. For instance, certain organic matter may stimulate the development of specific micro-organisms or groups of them, for which the substance is particularly suited. The change may be accomplished by the addition of lime, sulphur, ammonium salts, phosphorus and other chemicals, or by simply drying or wetting the soil, such as would occur when the moisture content of the soil is affected by a period of drought or excessive rainfall, by raising and lowering the temperature, or by a change in aeration, all or any of which may modify quantitatively or qualitatively the soil's population. Further, Greaves (2) tells us that the total number of certain micro-organisms in cultivated soil may be twice as large as it is in the same soil when virgin, and that it was higher in wheat land than in alfalfa land.

¹A contribution from the Division of Botany, Experimental Farms Branch, Department of Agriculture, Ottawa, Canada, co-operating with the Department of Field Crops, University of Alberta; read at meeting of Western Canadian Society of Agronomy, C.S.T.A. Convention, Winnipeg, June, 1932. (Abstract).

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The foregoing factors are touched upon because of their possible significance in controlling or reducing the activity of soil-borne pathogens by cultural or other practices. At present we do not know whether the reduction in disease that follows a certain crop or practice is due to an actual decrease of the pathogen in the soil, or whether the pathogen is still as abundant but its virulence modified by other antagonistic micro-organisms.

I shall now discuss some of the important plant diseases, the pathogens of which are soil-borne, taking first the root-rots of cereal crops caused by *H. sativum*, *O. graminis* and *Fusarium* sp. We know that, normally, these persist indefinitely in the soil, and that they subsist on the soil nutrients, including undecomposed organic matter, but what nutrients or organic matter, or other substances or conditions are most favourable, is not well understood. It is observed that the disease is usually much reduced by a summer-fallow, and by certain, non-susceptible crops, so we assume that a quantitative reduction of the pathogen has occurred—but has it, and if so, why? That it may be influenced profoundly by the antagonistic effect of certain other micro-organisms in the field soil now appears a possibility, judging from the results obtained by Sanford and Broadfoot (5), in which a number of soil-inhabiting fungi, bacteria and actinomycetes were found to control completely the virulence of *O. graminis* on wheat seedlings in soil, under greenhouse conditions. On the other hand, some of these micro-organisms appeared to offer no control whatever, in fact some seemed to increase the virulence of the pathogen. Further, various combinations of micro-organisms may produce various results, probably depending on the kind and amount present, and the environmental factors under which they act.

A problem which for a long time has puzzled us is to inoculate artificially the soil for field studies, in connection with testing varieties of wheat for resistance to the root-rots. So far, we have been unsuccessful, the results being practically negative. Our laboratory and greenhouse experiments have shown conclusively that the reason for this is that the pathogenicity of the inoculum is quickly reduced by being thrown, as it were, into a new association with numerous other micro-organisms, the combined effect of which controls the virulence of the particular pathogen. Whether the effect is entirely quantitative or qualitative, or both, we have been unable to determine as yet. If the pathogen is placed immediately in sterilized soil, it strikes down the wheat seedling with ease, but if the same soil, inoculated, remains exposed to the air and receives ordinary tap water, as has been demonstrated in our laboratory by Broadfoot (1) wheat planted from 10 to 20 days afterwards escapes almost wholly, and thereafter the damage is insignificant. It would appear that until we can artificially duplicate nature in the field, in this connection, our field work in testing for resistance must be seriously curtailed. However, the fact that under certain, as yet obscure, conditions in nature, the pathogens are able to demonstrate their virulence, should encourage attempts to understand the secret.

If we attempt to analyze why the root-rots of cereals, and of certain other crops, are reduced by summer-fallow, or some other non-susceptible crop, at least two theories may be suggested. First, that in the absence of a susceptible crop the pathogen languishes for food, and is thereby diminished.

This theory is the one which has had general acceptance, but for which proof is lacking. A second theory that might be advanced is that the biological equilibrium of the soil flora and fauna, which has become favourable for the pathogen under successive crops of wheat, is adjusted in such a way by a change in crop or cultural practice that its pathogenicity is held to a minimum.

Common scab of potato is another interesting disease from the standpoint of the life of the pathogen, *Actinomyces scabies*, in the soil. The control of this well known malady is, apparently, still as baffling as ever in spite of attempts to control it by seed treatment, crop rotation, and cultural methods. Apparently the pathogen inhabits all ordinary virgin soils, the amount depending on the soil. Cases of common scab often occur following the first breaking, although the disease is commonly at a minimum on new land. The organism evidently increases with the cultivation of various crops, and may reach a very high amount even in the absence of a crop of potatoes, or any other susceptible crop. I have observed several cases of severe scab following two years of wheat and six years of timothy from virgin sod, and also after several crops of wheat or oats on land never before cropped to potatoes or manured. Like the other microflora, this pathogen seems to increase or decrease in the cropped soil, according to conditions, but whether it would do so as well in the absence of a crop is an interesting question. Further, in view of the various factors in the soil tending to increase or decrease the microflora it might be that the amount of this pathogen which would persist, would not be affected perceptibly by planting untreated scabby sets, or even by a scabby crop.

Of further interest is the suggestion of Millard (3) that green rye mixed in the soil reduced scab by increasing another organism, namely, *A. praecox*, which appeared to suppress *A. scabies*. Previous to Millard's results it was often hinted that the decomposing rye effectively increased the acidity of the soil. However, this would seem a practical impossibility, which has been demonstrated by myself (4) in 1925 and since verified here. No doubt a green crop might affect both the kind and amount of the soil's micro-flora. Furthermore, I have recently demonstrated in the laboratory that certain other soil inhabiting bacteria and fungi may greatly modify the growth of *A. scabies* in sterilized soil, and that others appeared to have little or no effect. Therefore, in view of the evidence, it would seem that more knowledge concerning the life of this pathogen in the soil is required for an adequate understanding of the disease.

The Rhizoctonia scurf or stem canker of potatoes is another soil-borne disease about which there is very little reliable information regarding the pathogen's normal life in the soil. In many respects it now appears to present a very similar problem to that of potato scab from the standpoint of control. This organism is common in virgin soils, living mostly as a saprophyte. Its increase with cultivation is probable. It is assumed that continuous cropping to potatoes favours its increase, yet one doubts, at least in our Western soils, that this crop favours it much, if any, more than many other crops, the application of stable manure, or green crops. From work which we have done at our laboratory, it would seem that more should be known about the factors which favour either the rise and fall of this pathogen in the soil, or the conditions under which it becomes virulent. Certainly the absence of

sclerotia on the tubers is not a reliable sign that this parasite is not abundant in the soil, any more than an abundance of these bodies indicates that it is more than normally prevalent there.

If time permitted I might enlarge on some other soil-borne diseases. However, I have indicated enough to suggest the interest soil micro-biology holds for the plant pathologist.

REFERENCES

1. BROADFOOT, W. C. Studies on foot- and root-rot of wheat. I. Effect of age of the wheat plant upon the development of foot- and root-rot. *Can. Jour. Res.* 8: 5. 1933.
2. GREAVES, J. E. A study of bacterial activities in virgin and cultivated soils. *Centrbl. Bakt.* II, 41: 444-459. 1914.
3. MILLARD, W. A. and TAYLOR, G. B. Antagonism of microorganisms as the controlling factor in the inhibition of scab by green manuring. *Ann. Appl. Biol.* 14: 202-216. 1927.
4. SANFORD, G. B. Some factors affecting the pathogenicity of *Actinomyces scabies*. *Phytopath.* 16: 525-547. 1926.
5. _____ and BROADFOOT, W. C. Studies of the effects of other soil-inhabiting micro-organisms on the virulence of *Ophiobolus graminis* Sacc. *Sci. Agr.* 11: 512-528. 1931.



Baby beef in Western Canada

THE SUITABILITY OF IMMATURE SWEET CORN FOR SEED

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In Manitoba the production of seed corn is attended by considerable risk, one reason being that the season is rather short and killing frosts often occur before the corn is fully mature. In view of the fact that the quantity of garden seed corn imported into Canada and into Manitoba amounts in some years to over 1,000,000 and 40,000 pounds respectively, it was thought desirable to investigate the utility for seed purposes of sweet corn harvested in an immature state.

EXPERIMENTAL

Sweet corn seed of the Burbank Golden Bantam variety, M.A.C. selection, was planted in an isolated portion of the garden at the Manitoba Agricultural College on May 20th, 1931. It was planted in rows 3 feet apart with the plants approximately 9 inches apart in the rows. Cross pollination was permitted and throughout the season ears were tagged as soon as the silks appeared. The date of tagging was written on the tags. The first ears were tagged on July 25th and tagging continued until August 11th.

Ears were harvested on August 24th, Sept. 8th and Sept. 18th. Slight frosts had occurred just previous to the last harvesting date, but not severe enough to injure the kernels. Dates of harvesting the ears were entered on the tags, the husks removed at the time of harvest and the tags securely fastened to the ears. To complete curing, the ears were placed in open mesh baskets and immediately after harvest were stored until about June 1, 1932, in a well ventilated house basement free from frost.

For the germination tests reported in Table 1 and Table 2, only the kernels from the middle portions of the ears were taken and the kernels from all ears of the same "age" were bulked together. Facilities for weighing the samples and making laboratory germination test (Table 1) were provided in the laboratories of the Dominion Seed Branch, Commercial Building, Winnipeg. A Minnesota germinator, thermostatically controlled at a temperature of 20° to 30° C., was used, and the samples were planted among ordinary fine sand in specially made cardboard boxes which were placed on trays in the germinator. No selection of kernels was made for the samples weighed. Duplicate samples of each lot were weighed and placed in the germinator on June 7th, 1932. Data concerning the laboratory germination test are given in Table 1.

Observations made on the seed itself and its behaviour in this test follow.

(a) It was difficult to handle samples 1, 2 and 3 after the first count in the laboratory germination test owing to the fact that many sprouts and roots had decayed at or near the kernels after they had been replaced. (This accounts for the large number in the "dormant" column of sample 2).

(b) Samples 4 to 14, inclusive, were considered quite good samples of seed as indicated by appearance, weight of kernels, and notes taken at the time of the first count June 13th.

¹Horticulturist.

TABLE 1.—*Laboratory germination test of sweet corn.*

Sample	Date silk appeared	Date harvested	"Age" of ears in days & No.	Weight 50 kernels in grams	No. germinated*		Per cent germination	No. dormant
					June 13	June 16		
1 A	Aug. 11	Aug. 24	13	2 1.99 1.37	11 9	2 —	26 18	2 4
1 B	"	"						
2 A	Aug. 9	Aug. 24	15	3 1.23 1.43	7 9	— —	14 18	27 22
2 B	"	"						
3 A	Aug. 3	Aug. 24	21	5 3.11 2.50	31 32	8 1	78 66	2 3
3 B	"	"						
4 A	Aug. 7	Sep. 8	31	6 6.76 6.95	49 50	— —	98 100	1 —
4 B	"	"						
5 A	Aug. 9	Sep. 18	39	3 7.65 6.90	47 42	— 4	94 92	— 2
5 B	"	"						
6 A	Aug. 6	Sep. 18	42	3 7.07 7.32	49 48	— 2	98 100	1 —
6 B	"	"						
7 A	Jul. 27	Sep. 8	43	7 9.64 9.21	49 48	— 1	98 98	1 1
7 B	"	"						
8 A	Aug. 5	Sep. 18	44	3 6.74 6.85	49 47	— 1	98 96	— 1
8 B	"	"						
9 A	Aug. 3	Sep. 18	46	7 9.24 9.17	46 45	2 4	96 98	1 1
9 B	"	"						
10 A	Aug. 1	Sep. 18	48	10 8.76 8.21	47 47	— 2	94 98	1 1
10 B	"	"						
11 A	Jul. 30	Sep. 18	50	6 9.18 9.31	50 46	— 2	100 96	— 1
11 B	"	"						
12 A	Jul. 29	Sep. 18	51	6 10.16 10.02	45 41	4 6	98 94	1 —
12 B	"	"						
13 A	Jul. 28	Sep. 18	52	7 11.17 11.16	38 39	8 5	92 88	2 3
13 B	"	"						
14 A	Jul. 25	Sep. 18	55	6 9.80 10.20	49 49	— —	98 98	1 1
14 B	"	"						

*Seeds were considered to have germinated when a strong sprout had developed and numerous fibrous roots were present on the strong main root. Germination counts were made on the 6th and 9th days of the test.

(c) In all samples a certain number would be slow to germinate (appear above ground) if planted in the field owing to apparently strong sprouts appearing to stick in the pericarp of the kernel. Especially was this true of samples 12 and 13, i.e., the more mature kernels.

Besides the data given in Table 1 the following conditions were also observed. On some kernels there had developed (a) sprouts and roots but no fibrous roots (especially in samples 1, 2 and 3), (b) sprouts but no roots (especially in samples 1 and 2) and (c) roots but no sprouts (especially in samples 1 and 13 and perhaps 2). In some cases roots had developed at the time of the second count *above* the kernel, where sprouts but no roots had developed at the time of the first count.

Samples of all lots with the exception of 1 A and 1 B were again weighed on June 23rd and planted in the garden at the Manitoba Agricultural College on June 27th. In planting them a continuous furrow from 2 to 3 inches deep was made with a hoe and the seeds scattered in it, each lot of 50 seeds occupying about nine linear feet of row. The seeds were covered with soil immediately after being planted, and the soil made firm over them by treading with the feet.

TABLE 2.—*Field germination test of sweet corn.**

Sample See Table 1 for particulars	Weight 50 kernels in grams	No. of plants produced July 20	Per cent germination	Remarks
2 A	1.54	11	22	
2 B	1.56	12	24	Weak plants and not uniform
3 A	3.25	40	80	
3 B	2.87	46	92	Some rather weak plants
4 A	6.77	48	96	
4 B	6.62	48	96	A few weak plants
5 A	6.54	50	100	
5 B	7.97	45	90	A few weak plants
6 A	7.48	49	98	
6 B	7.24	48	96	One or two weak plants
7 A	9.65	50	100	
7 B	9.50	49	98	Plants all strong
8 A	6.65	45	90	
8 B	6.85	47	94	Plants all strong
9 A	8.64	45	90	
9 B	9.17	44	88	One or two weak plants
10 A	8.18	44	88	
10 B	8.15	45	90	Plants all strong
11 A	9.47	46	92	
11 B	9.77	45	90	Plants all strong
12 A	9.99	49	98	
12 B	9.94	45	90	Plants all strong
13 A	10.77	43	86	
13 B	10.70	40	80	Plants all strong
14 A	10.18	46	92	
14 B	10.10	42	84	Plants all strong

*Plants were about 15 inches high on July 20th; they were all of strong and equal vigor, especially samples 7 to 14 inclusive and no recounts were made.

SUMMARY

Sweet corn of the Burbank Golden Bantam M.A.C. selection was harvested at various "ages", namely 13 to 55 days from silk to harvest.

All kernels of the same "age" were bulked together for the weight and germination tests conducted.

Weight of kernels increased gradually with "age" except in the case of samples No. 6 to 10 inclusive. This irregularity is difficult to explain unless

the very dry weather experienced at that time brought about uneven development.

Of especial interest is sample No. 7. The ears were in silk early and were harvested early and the average weight of kernel was high.

In both tests germination was low in the very immature samples, but from samples No. 4 (31 days from silk to harvest) to No. 14 (55 days from silk to harvest), inclusive, the average germination ranged from 90% to 99% in 9 days for the laboratory test and from 83% to 99% in 27 days in the field test.

From the results obtained in this experiment it would seem reasonable to expect good germination and strong plants from quite immature but fairly well developed sweet corn seed that has been well cured and carefully stored. Early developed ears and kernels attained large size in fewer days than late developed ears and kernels (see samples 7 A and 7 B). Because of this condition early planting is desirable for seed production so that ears might be reasonably mature and fit to harvest before danger of frost damage in the fall.

ACKNOWLEDGEMENTS

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An Ontario hill pasture.

A CO-OPERATIVE INVESTIGATION OF THE QUANTITATIVE RELATION BETWEEN SUMMER-FALLOW METHODS AND THE WIREWORM IN SASKATCHEWAN

A PROGRESS REPORT

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Almost from the commencement, in 1922, of the wireworm research in Saskatchewan, the great need has been felt for some adequate quantitative investigation of the relation of the summer-fallow to this pest. Field observations early established (1) the facts that the most severe damage by prairie wireworms occurs almost invariably to the crops seeded on summer-fallow, and that as a rule the heavier wireworm infestations are associated with fields which have been for years under continuous cultivation in a grain rotation of which summer-fallowing constitutes a very important feature.

Especially was this need felt when it began to be realized (2) what great differences in the rate of damage by this pest, even to the same crop and variety, occur without material change in wireworm population. This discovery pointed to the possibility, at least, that the apparent effect of the summer-fallow and the differences observed between different methods of fallowing, might be related in large measure to rate of damage and not to infestation. Some confirmation of this inference was given by the discovered facts that our most important wireworm species require several years for development, that the wireworm populations usually change very slowly, and that in the first year after hatching the larvae probably are unable to cause much damage to crops. At the same time, there seemed a strong probability that the methods used in fallowing might have important bearing on the magnitude of wireworm infestations *eventually* established in different fields, and that through the summer-fallow might be found the best approach to the difficult problem of lessening the numbers of this resistant pest.

An early consummation of the plan for quantitative research in this direction was negatived, not only by the great amount of work involved, but more especially by the lack of the necessary facilities. A project of this kind necessitates, in addition to the strictly entomological study, an extensive and detailed program of tillage, rigidly maintained over a period of years. To do this virtually requires that a suitably infested field be close to a governmental experiment station, and that it be under control for a suitable period. Moreover, it was highly desirable that the field to be utilized in such an investigation should be broadly representative of the "medium" soils in which important persistent infestations of this pest have most typically occurred under cropping systems in which grasses are rarely if ever used.

This combination, however, was at last revealed when it was discovered that the "Washington farm", under lease to the Dominion Experimental Station at Swift Current, Sask., was infested by wireworms to such an extent

¹The publication of this entomological article has received the approval of our collaborator, Mr. J. G. Taggart, Superintendent of the Dominion Experimental Station, Swift Current, Sask. Grateful acknowledgement is given of the very material aid received from Mr. Taggart, especially with respect to agronomic phases; and from officers and employees of that Station and of this Laboratory, in the extensive field work of this project.

that experimentation along many other lines could not profitably be carried on, the results generally being obscured by the dominant influence of the pest. A cordial proposal in 1929, by the Superintendent of that Station, that the problem be attacked in a co-operative project was enthusiastically embraced. Preliminary work that year led to the inception in the early spring of 1930 of the work described below.

In planning the project—it is pertinent to state—there was virtually no entomological precedent to follow, and the principles at present accepted in agronomic practice could only serve as a general guide. For example, while the necessity for replication was recognized, there seemed to exist no basis upon which to determine what might constitute adequacy of replication in respect to the known local variability of wireworm infestation. Other important considerations for which no background existed, such as the proper division of the time available, and suitable allowance of space to minimize effects of Elaterid migration, will suggest themselves. As a consequence of this situation, the results of the project relate not only to immediate practical findings but also to an appraisal of the methods of study themselves.

With these introductory remarks to indicate the background of the work, the entomological results secured in the first three years, 1930, 1931, 1932, are summarized, followed by a brief statement as to the methods used in the investigation.²

PRELIMINARY RESULTS

The purpose of this experiment is to test on a field scale, by means of replicated plots, the effect of *four* different methods of summer-fallowing upon wireworm populations and upon the rates of wireworm damage to wheat crops.

During the comparatively short period that this project has been maintained, it has yielded very gratifying results and bears every assurance of justifying the expenditure of time and labour involved in its continuation for at least a suitable minimum period. These results, which to date are in many respects preliminary, may be considered in several aspects:—

1. Immediate practical bearing, as respects (a) reducing the rate of damage by wireworms, and (b) reducing the wireworm numbers.
2. Information of general entomological or scientific interest.
3. Adequacy of the methods used in the investigation, as concerns (a) the tillage procedure, (b) the annual wireworm census, and (c) the counts-of-damage work.

In general, the methods used, and the system of impersonally distributed replicate plots as established, seem entirely satisfactory within the limits of time and labour available for the purpose in view, and the wireworm population is sufficiently high and uniform to allow of reliable statistical analysis. The counts-of-damage work seems particularly complete.

Important results of immediate practical bearing have already been secured. Naturally, these have so far chiefly related to means of reducing the rate of damage by wireworms. Probably the most important of these is

²A paper giving a detailed description of the methods employed is planned for the near future. (World's Grain Exhibition and Conference, Regina, 1933.)

the clear demonstration of the importance of seeding wheat, on wireworm-infested soils, when the conditions are most favourable to germination and rapid early growth of the plants. In 1931, under poor germination conditions, up to 65% of the wheat was destroyed by June 2nd, before it emerged; in 1932, under excellent conditions for growth, 3.3% was the heaviest seed damage recorded. Sufficient moisture at this stage appears to be the most important factor in this connection, and can usually be secured, if necessary, by somewhat delaying the otherwise rather early seeding desirable in fields infested by this pest.

The fact that in some years there is very little wireworm damage to the seed, whereas seedling and plant injury always constitutes a very important proportion of any injury that does occur, confirms our previous conclusions of the inadequacy of any treatment (even if an effective practical one could be devised) which protects only the seed.

As respects the influence of the fallow methods upon subsequent rate of wireworm damage, the "Surface Cultivation", involving only shallow tillage and preserving a firm subsurface condition, is the most promising of the fallow methods being tested. The plots summer-fallowed in 1931 by this method, yielded in 1932 over three bushels per acre more than the corresponding plots of any other method. In contrast, the plots of deep, excessive tillage were most seriously damaged by wireworms and produced approximately 5 bushels less per acre.

The exact data obtained in the counts of damage completely disprove the theory often advanced, that wireworm injury, if not too extensive, is of no material importance on the final yield, the grain plants (by extra tillering) compensating for the destruction of other plants and stems, up to the limit set in any event by the available water supply. On the contrary, it is evident that under the conditions obtaining at Swift Current (which is representative of much of the prairie wireworm area) the crop is only able to fully utilize the available moisture if it gets well started ahead of the weeds and is able to smother them; consequently, any set-back to even a single plant or stem allows extra development of the weeds to such an extent as to consume not only the moisture which would otherwise have been utilized by the destroyed plant, but also a considerable part of that which would have been available (had the weeds been smothered) to the surrounding plants and stems.

As was expected in view of the several years required to complete the life-cycle of a wireworm, and the relatively short time since the contrasting soil conditions became definitely established in the plots, it is not yet possible to issue a conclusive statement on the effects of the various cultural treatments on wireworm populations. Certain indications, however, seem worthy of mention. It is already strongly evidenced that excessively deep plowing may frequently be associated with a subsequent marked increase in wireworm population. It is also indicated that the method ("Surface Cultivation") which tends to reduce rate of damage following fallow, at least does not tend towards increase of the wireworm population; furthermore, this is the least expensive of the methods used, and seems also to be meeting increasing favour from a variety of other viewpoints, such as the destruction of annual and perennial weeds and the control of soil drifting. The significant decrease of population since 1930, in the plots summer-fallowed by all four methods,

points to the possibility that clean tillage in the summer-fallow year may lessen wireworm survival, a condition which has been found of importance with other wireworms under semi-arid conditions. The data definitely suggest that the rate of population decrease has been distinctly less in those plots fallowed by the deep, late "July plowing" method; if this proves to be the case it is a direct reversal of the recommendations often previously made, on theoretical grounds; at any rate this lead emphasizes the importance of securing more exact information.

The different soil conditions, characteristic of the four summer-fallow treatments, are now well established on the experimental plots. It is, therefore, reasonable to expect, within the next few years, significant results relative to wireworm-population trends, eventually permitting reliable and rather widely applicable conclusions to be drawn.

No extended discussion of the results of general entomological and scientific interest will be entered into at this time. Some of this information, particularly that relating to wireworm distribution, will doubtless eventually prove to have a practical bearing. It has been found that the year-to-year correlation of wireworm populations is very high as between very localized areas (for example, between plots) although it is low as between individual samples. In other words, local differences in rate of infestation tend to persist; this may be on account of local soil variation or may merely be the result of the long life-cycle which in itself would tend to perpetuate (for several years at least) any local difference which became accidentally established. This finding has a bearing upon methods of sampling for census purposes in that it indicates that random sampling may not be satisfactory (for purposes of comparison of a given area from year to year) unless the samples are distributed on each occasion with complete symmetry, or at least in identical fashion.

Both the plan and the maintenance of the tillage operations have proved to be very satisfactory. The operations have required more exacting attention to detail than those ordinarily used in field-scale work. This care has been gratifyingly reflected by the marked contrasts obtained in soil conditions. For example, in the spring of 1932, plots fallowed by the four methods in 1931 could be easily distinguished (without prior knowledge of the arrangement of the plots) both in visual appearance and in their compactness, as indicated by walking over them as well as in their different reaction to spring tillage operations.

Preliminary (although rather extensive) statistical analysis indicates that the methods used for making an annual census of wireworms are reasonably adequate, but final conclusions on this point must await much further study and appraisal. Since each method of fallowing is represented by 90 census samples of which 30 represent each year of the sequence (10 samples in each of 3 plots), it is believed that the procedure should eliminate or minimize the influence both of local field variations and, ultimately, of the varying effects of the weather encountered in different seasons. The mean wireworm populations for each of these 4 groups of 90 samples showed no statistically significant differences at the beginning of the experiment, and virtually the same condition obtained as between the groups of 30 samples (representing each year of the sequence for each method). As a consequence

of this initial condition, not only the relative trends of population, but also the absolute population that eventually develops in each group of plots, should be of significance as reflecting the effects of the tillage practices which have been maintained. In common with most work of this kind, greater accuracy could have been secured by having a larger number of census samples, but it cannot yet be determined whether any greater efficiency of effort (considering the time requirements of the entire project) would have been secured had, for example, twice the number of census samples been maintained in each plot since the beginning of the investigation.

INVESTIGATIONAL PROCEDURE

The insect work is discharged by the Dominion Entomological Laboratory, of Saskatoon, in co-operation with the Dominion Experimental Station, at Swift Current, which provides acreage and maintains the desired cultural treatments.

Situated in the heart of a vast area plagued annually by wireworms, the experimental plots, with their natural infestation, are almost ideally adapted for this work. Under the present "layout", there are 47 experimental plots, each 2 chains square and two-fifths of an acre in area. This size and shape was selected to minimize the possible effects of wireworm migration. Including roadways, the total area under investigation approximates 20 acres. Each summer-fallow method is represented by 9 plots, 3 of which are summer-fallowed each year, thus annually providing triplicated sets of data on each phase of the wheat-wheat-fallow rotation which is being practised. The replicate plots of each method are not contiguous but are impersonally distributed to eliminate localized field influences. Two types of check plots are provided; one group of six is continuously cropped with wheat, never fallowed; another group of six is deeply and excessively cultivated in the "crop" as well as the "fallow" years.

The summer-fallow methods are designed on a practical farming basis, each being patterned on methods in more or less constant use throughout the dry-farming, prairie regions where the wireworm is most destructive. Extreme care has been exercised in the selection of implements, and in the determination of dates and depths of operations, so that current knowledge and theories regarding wireworm populations and damage can best be utilized and tested. Sufficient differences are provided in the four methods to compare the effects which may be produced by extreme contrasts in depth and degree of looseness of the soil, or of the time (and depth) of various operations relative to the egg-laying or the pupal periods.

Method I, is the "Common Method" employed in the district, and in the province. Plowing $4\frac{1}{2}$ " deep in late May or early June is followed by tillage of moderate depth, and only as required to control weeds.

Method II, "July Plowing", involves shallow spring tillage with plowing $6\frac{1}{2}$ " deep in late July and subsequent shallow tillage as needed for weed control.

Method III, "Surface Cultivation", is never plowed, thus maintaining a firm subsurface. Special shallow tillage in late July is designed to destroy the fragile pupae.

Method IV, "Excessive Tillage", typifies the procedure of the so-called "good" farmer who desires to keep his fallow "black" at all times. Plowing 7"-8" in mid-June follows deep spring tillage. All treatments are *deep*, and *oftener* than needed for weed control.

In keeping with the purpose of the experiment the field work falls into two chief categories: (1) the wireworm population study; (2) the wireworm damage study. This is a *field study*; consequently, all measurements and determinations of wireworms, all observations of wireworm damage, and all plant measurements are made and recorded in the field. No insect material is removed from the plots.

The population of wireworms and of overwintering adults is determined by using "standard" methods to secure and examine a sufficient number of "square-foot" soil samples³, taken annually, at *permanent* locations, impersonally selected, in the central portion of each plot. These "census" samples are taken during May and early June, before the current year's brood is hatched, and they are not repeated until the following spring. The study, therefore, is not continuous throughout the season, but permits of comparison only from one spring to another. By sampling at this time of the year, when the wireworms are most active and nearest the soil surface, the most accurate population counts are obtained with the minimum expenditure of time and labour. The technique involved has the combined advantages of accuracy, inexpensiveness, and simplicity. No mechanical contrivances are used; pails, with simple sieves and trays, form the major part of the equipment.

The rate of wireworm damage is secured by making periodic examinations on a sufficient number of impersonally selected "square-foot" samples⁴ of wheat plants at permanent locations, adjacent to the "census" samples, in the central portion of each cropped plot. These are "permanent" samples in that they remain staked all season, and, through periodic examination, provide a *continuous* record of the wireworm damage from the first emergence of the wheat plants until they are harvested. This study is supplemented by: (1) examining of the wheat kernels found in the "census" samples for data on wireworm damage to seed; (2) making counts of tillers and crown roots on the plants of certain "census" samples; (3) digging up samples in June to observe the development of, and damage to, the underground parts of the wheat plants; (4) tagging tillers of various selected heights, in July, to observe their subsequent developments; (5) charting the crop "stand" on each seeded plot as to "normal", "thin", "very thin", etc., areas; (6) measuring at harvest time, the length of heads and stems, and estimating the degree of maturity, of the plants growing under the various cultural treatments; (7) obtaining yield data from (a) plants retained from certain of the "damage" samples, (b) from a sufficient number of "rod-row" samples from each seeded plot, and (c) from bulk yields obtained by cutting and threshing each plot as a unit.

³479; 495; 545 samples taken in 1930, 1931 and 1932 respectively; 10 samples are taken per plot, located by measurement and approximately duplicating themselves from year to year.

⁴290 and 300 "permanent" samples were, respectively, under observation in 1931 and 1932; 10 samples per plot are taken, roughly paralleling the census samples and procedure.

REFERENCES

1. KING, K.M. Economic importance of wireworms and false wireworms in Saskatchewan, *Sci. Agric.*, 8: 699. 1928.
2. ————— The value of quantitative methods in the investigation of field crop insects, with special reference to work with wireworms and cutworms. IV Internat. Cong. of Ent., 2: 255. 1929.

CURRENT PUBLICATIONS

MORE MUTTON AND LAMB FOR BRITISH PASTURES

IMPORTANT DISCOVERY BY SCOTTISH SCIENTISTS

One of the chief reasons why the sheep-carrying capacity of our grasslands remains low is that close stocking almost always leads to disease, particularly liver fluke and stomach worm, which are responsible for very large losses in our sheep population. Hitherto we seem to have spent too much thought on curing affected animals and too little on prevention. It is therefore satisfactory to learn that Dr. J. B. Orr, of the Rowett Research Institute, and his collaborators at Aberdeen, have taken up the systematic study of the subject from the standpoint of nutrition, rather than from that of the veterinary surgeon.

The first-fruits of their investigation have just been published in the *Empire Journal of Experimental Agriculture* (published by the Oxford University Press) in the form of an article by Dr. A. H. H. Fraser, of the Rowett Research Institute, and Mr. David Robertson, of the North Scotland College of Agriculture, which throws some very interesting light on the connection between the nutrition of sheep and their susceptibility to the stomach worm, *Haemonchus contortus*. This worm slays its thousands, nay its tens of thousands, in practically all the chief sheep-growing countries of the world, including those of the British Empire, which in the aggregate contain one-third of all the world's sheep.

The experiment was carried out on 32 well-fed lambs, aged three months, which were divided into two groups, one of which was fed on a daily ration of 7-8 lbs. of green tares and bruised oats per head, and the other received, in addition, 3 pints of separated milk and 1 lb. of mixed meals. At the end of one month, the average weights in the two groups were 60 lbs. and 84 lb. respectively. Both groups were then turned out on a naturally infested pasture that had been heavily grazed, and precautions were taken to ensure that each group had an equal chance to pick up the same number of worms. The well-fed group continued to receive the pound per head of meals, but the separated milk was discontinued. After 46 days all the lambs were slaughtered and the contents of their fourth-stomachs were examined for worms. The average number in the poorly fed group was 103, as against 31 in the well-fed group.

The experiment shows without a doubt that the susceptibility of the lambs to infestation with the stomach worm was closely connected with their state of nutrition. We may conclude, therefore, that the provision of an adequately nutritious diet at the right stage of development is essential if we are to keep our flocks immune from disease. As the staple diet of grassland sheep in Great Britain consists of grass and a little hay, the question of improving the quality and yield of our pastures is naturally concerned. Although the authors do not discuss this question, it is fairly obvious that their results have a bearing on the use of fertilizers, nitrogen, phosphates, potash and lime, on grassland, which together with better cultivation and the use of more leafy and nutritious strains of grasses, are needed to improve the quality and quantity of herbage in most countries of the world.

AN EVALUATION OF CANADIAN FEEDS ON THE BASIS OF DIGESTIBLE NUTRIENTS¹

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The nutrients contained in a feed are in most cases the basis for estimating the value of that feed. Attempts to indicate a relative valuation of feeds have too often failed, because, after duly arriving at a price per pound of protein, carbohydrates, or fat, as many systems advocate, no consideration is given to the other ingredients in the feed. In using, as a basis of comparison, the protein and non-protein content of a feed, the "Petersen formula for evaluating feeds on the basis of digestible nutrients" (2) overcomes this difficulty. The "protein" of a feed refers to Digestible Crude Protein (D.C.P.) and the "non-protein" content to the Total Digestible Nutrients (T.D.N.) minus the D.C.P.

In view of the sound basis on which the Petersen formula is founded, and because "Digestible Nutrients" are accepted as a universal standard of comparison, this formula seems worthy of greater consideration and of adaptation to Canadian conditions.

It will be well to keep in mind at the outset that the scope of this evaluation is, in some ways, limited; that in using the nutrients in a feed as the basis of evaluation there is a wide range in the quality of proteins; that fish meal and tankage, for example, are primarily purchased for their protein and supplementary value, and cannot be accurately evaluated relative to barley and linseed oilmeal; that bran probably has special nutritive value, through its tryptophane content; in short, it is recommended that practical feeding knowledge be kept always to the fore, so that the aims of this evaluation will not be defeated. In adapting this formula to Canadian conditions, it is hoped that the relative values of the feeds may be used as a feed purchasing guide, and also, that these relative prices might be used in developing a standard price list, which in turn would enable experimentalists to make the results of feeding trials more directly comparable and hence, of greater value.

Originally, this formula was developed by Petersen to meet conditions in the United States. He used cottonseed meal and corn as the basal feeds in his relative evaluations, as they represented in that country the cheapest source of protein and total digestible nutrients, respectively. In Canada the place of the above feeds is taken by linseed oilmeal and barley. They not only occupy a like position to that of cottonseed meal and corn in the United States, but make an ideal basis for comparison because they are used extensively and meet with wide popularity.

The development of the formula is simple, yet complete, and is here given in as concise a form as possible. In 100 pounds of oilmeal there are 30.2 pounds of D.C.P. and 77.9 pounds T.D.N., and by difference 47.7 pounds of non-protein digestible nutrients. By calculation 67.76 pounds of barley (9.0% D.C.P. and 79.4% T.D.N.) contain a like amount of non-protein digestible nutrients, namely, 47.7 pounds, and also 6.1 pounds

¹An adaptation of the Petersen (2) formula.

²The assistance and criticism of Messrs. Geo. W. Muir, and E. B. Fraser, Dominion Animal Husbandman, and Animal Husbandman respectively, of the Central Experimental Farm, Ottawa, Ont., were greatly appreciated and are here acknowledged.

of protein. So it is seen that other things being equal any difference in the cost of these two amounts of feed, 100 pounds of oilmeal and 67.76 pounds of barley, can be attributed to the difference in the content of protein, i.e. $30.2 - 6.1 = 24.1$ pounds, the non-protein content of both amounts being identical, 47.7 pounds. The value of one pound of protein can be determined by using present prices, say barley at \$23.00 per ton, and oilmeal at \$32.00 per ton. The following formula is presented, having been adapted from Petersen's formula to apply to Canadian feeds.

The value of one pound of protein:

$$\frac{(\text{Cost of } 100 \text{ lbs. oilmeal}) \text{ minus } (\text{cost of } 67.76 \text{ lbs. barley})}{24.1 \text{ lbs. protein content difference}} =$$

$$\frac{(100 \times \$32.00 \text{ per ton}) - (67.76 \times \$23.00 \text{ per ton})}{24.1} =$$

$$\frac{\$1.60 - 0.779}{24.1} = 3.41 \text{ cts. per pound protein.}$$

The value of a pound of non-protein digestible nutrients is then calculated by substituting the value of a pound of protein, thus:

$$\frac{(\text{Cost of } 67.76 \text{ lbs. barley}) \text{ minus } (\text{value of } 6.1 \text{ lbs. protein})}{47.7 \text{ lbs. non-protein content}} =$$

$$\frac{(67.76 \times \$23.00 \text{ per ton}) - (6.1 \times 3.41 \text{ cts. per lb.})}{47.7} =$$

$$\frac{\$0.779 - 0.208}{47.7} = 1.197 \text{ cts. per pound non-protein.}$$

To find the value of a feed, relative to the value of barley and oilmeal, multiply the pounds of digestible protein in that feed by 3.41 cents, and add the result to the product of the pounds of non-protein digestible nutrients in the feed multiplied by 1.197 cents per pound. For example, oats contains 1408 pounds T.D.N., and 194 pounds D.C.P. per ton. Taking the difference of these values, oats contains 1214 pounds of non-protein digestible nutrients. Thus, $(1214 \times 1.197) + (194 \times 3.41)$ equals \$21.15 per ton. That is, oats has a relative value of \$21.15 per ton, when barley is \$23.00, and oilmeal \$32.00 per ton.

The development of constants that are used to meet changing price levels greatly enhances the value and scope of this method of relative evaluation.

The following calculations and deductions are used in determining the constants or factors which are employed in the tabular work. When barley is \$23.00 per ton, and oilmeal is \$32.00 per ton, oats was shown to have a value of \$21.15. When barley is \$23.00 per ton, and oilmeal \$42.00 per ton, oats increases in value to \$21.96. The increase of \$10.00 in the value of oilmeal increased the value of oats \$0.81. The constant for oilmeal is 0.081.

On the other hand, when barley is \$33.00 per ton, and oilmeal stationary at \$32.00, the value of oats is \$29.23, which is an increased value of \$8.08 when barley increased \$10.00. The constant for barley is 0.808.

Thus the prevailing price of barley, multiplied by 0.808 plus the price of oilmeal multiplied by 0.081 will give the value of oats in relation to the prevailing values of barley and oilmeal. For example, $(\$23.00 \times 0.808) + (\$32.00 \times 0.081)$ equals \$21.17. This price is deemed sufficiently close to the value of \$21.15 to warrant the use of the constants instead of developing new values per pound of protein and non-protein nutrients at each change in the price of the base feeds.

The following factors are developed at this point because they have been used in computing the example of the constants, and are to be used in the table to follow.

The value of a pound of protein, when oilmeal is \$42.00 per ton, and barley \$23.00 per ton, equals

$$\frac{(100 \times \$42.00 \text{ per ton}) - (67.76 \times \$23.00 \text{ per ton})}{24.1} = 5.48 \text{ cents per pound protein.}$$

With similar prices one pound of non-protein is valued at

$$\frac{(67.76 \times \$23.00 \text{ per ton}) - (6.1 \times 5.48 \text{ cts. per lb.})}{47.7} = 0.933 \text{ cents per pound non-protein.}$$

When barley is \$33.00 per ton, and oilmeal \$32.00 per ton, the value of a pound of protein is

$$\frac{(100 \times \$32.00 \text{ per ton}) - (67.76 \times \$33.00 \text{ per ton})}{24.1} = 1.99 \text{ cents per pound protein.}$$

One pound of non-protein is valued at

$$\frac{(67.76 \times \$33.00 \text{ per ton}) - (6.1 \times 1.99 \text{ cts. per lb.})}{47.7} = 2.09 \text{ cents per pound non-protein.}$$

In Table 1 the values of the more common live stock feeds are compiled in relation to two standards, i.e., when barley and linseed oilmeal are respectively \$23.00 and \$32.00, and \$23.00 and \$42.00 per ton. Further, constants are set forth, having been developed in a manner similar to the foregoing example.

In order to show the use of Table 1 the following example is given: to find the value of bran at any specific time, take the price of oilmeal at that time and multiply it by the constant under the heading "For Oilmeal" opposite bran in the table, add the result to the product of the prevailing price of barley multiplied by the constant "For Barley" opposite bran. If the constant is preceded by a minus (-) sign, subtract in place of adding. The result obtained in either case is the relative value of bran at that date, using "digestible nutrients" as the basis of evaluation.

It was earlier intimated that the high protein feeds required special consideration. In Table 2 a relative evaluation of these feeds is developed on the basis of barley and 60% tankage.

The evaluation in Table 2 is made with barley and 60% tankage as the basic feeds, because these high protein feeds are not truly represented when evaluated on the basis of barley and linseed oilmeal. The table is constructed

TABLE 1.—*Constants by which the price per ton of barley and oilmeal can be multiplied to give a relative value of more common feeds**

Feed	Constant		Value per ton when	
	For Oilmeal	For Barley	Barley is \$23.00 Oilmeal is \$32.00	Barley is \$23.00 Oilmeal is \$42.00
Corn.....	-0.103	1.172	\$23.84	\$22.81
Buckwheat.....	-0.057	0.758	18.76	18.19
Oats.....	0.081	0.808	21.15	21.96
Oat Groats†.....	0.236	0.865	27.43	29.79
Wheat.....	0.062	1.047	23.25	23.31
Bran.....	0.262	0.510	20.11	22.73
Shorts.....	0.260	0.618	22.52	25.12
Middlings.....	0.320	0.670	25.67	28.87
Screenings (Standard Recleaned).....	0.152	0.530	17.04	18.56
Distillers' Dried Grains (Corn).....	0.576	0.552	31.20	36.96
Distillers' Dried Grains (Rye).....	0.262	0.431	18.32	20.94
Brewers' Dried Grains.....	0.656	0.003	21.18	27.74
Gluten Feed.....	0.582	0.542	28.88	34.70
Hominy†.....	-0.099	1.172	23.68	22.69
Alfalfa Meal.....	0.209	0.433	16.65	18.74
Cottonseed Meal.....	1.314	-0.315	35.09	48.24
Soybean Oilmeal.....	1.407	-0.328	37.80	51.87
Malt Sprouts†.....	0.575	0.322	25.88	31.63
Skim-milk.....	0.120	-0.004	3.77	4.97
Butter-milk.....	0.113	-0.009	3.53	4.66
Whey.....	0.004	0.074	1.84	1.88
Vim Oat Feed†‡.....	-0.101	0.525	8.76	7.75
Roughages:				
Alfalfa Hay.....	0.222	0.432	17.04	19.27
Clover Hay.....	0.086	0.557	15.55	16.41
Mixed Hay.....	-0.057	0.641	12.82	12.25
Timothy Hay.....	-0.116	0.727	12.94	11.78
Oat Straw.....	-0.194	0.768	11.36	9.42
Corn Silage.....	-0.042	0.265	4.72	4.30
Turnips.....	0.007	0.086	2.21	2.29
Mangels.....	-0.002	0.095	2.13	2.11

*The analysis of the feeds used, except where indicated are taken from Henry and Morrison's "Feeds and Feeding". Digestible figures only are used.

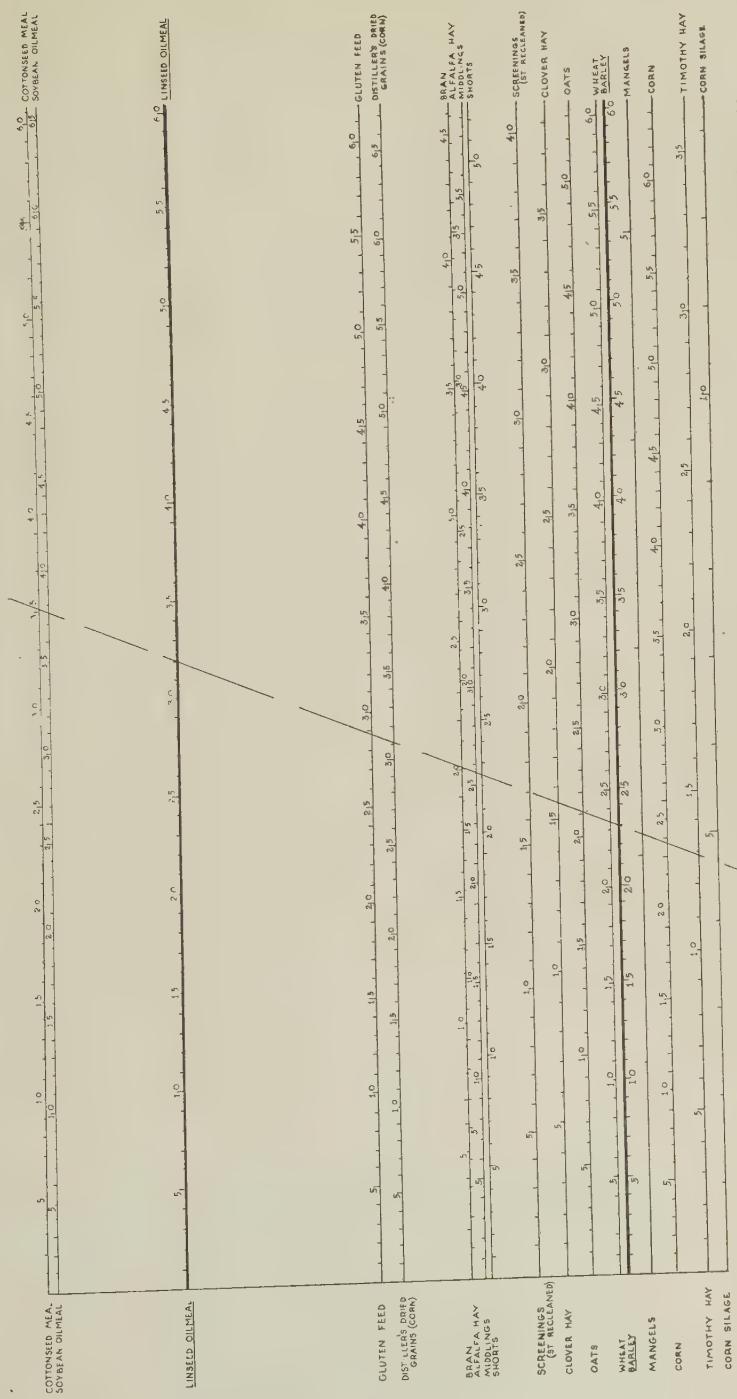
†Analysis made by the Division of Chemistry, Central Experimental Farm, Ottawa, with Henry and Morrison's digestible percentages applied to obtain the figures involved in the calculations of this work.

‡The analysis and coefficients of digestibility of "Vim Oat Feed" were made by the Division of Chemistry, Central Experimental Farm, Ottawa.

TABLE 2.—*Constants by which the price per ton of barley and 60% tankage can be multiplied to give a relative value of "Special Protein Feeds".*

Feed	Constant		Value per ton when	
	For 60% Tankage	For Barley	Barley is \$23.00 60% Tankage is \$40.00	Barley is \$23.00 60% Tankage is \$50.00
Tankage 50%	0.832	0.146	\$36.66	\$44.98
Tankage 45%	0.707	0.347	36.21	43.28
Meat and Bone Meal (37% D.C.P. 30-40% Ash)	0.624	0.219	29.95	36.19
Fish Meal 70%	1.272	-0.181	46.87	59.59

CHART FOR THE DETERMINATION OF THE RELATIVE VALUE OF FEEDS



TAKE THE PRICE PER TON OF BARLEY AND OILMEAL. THE POINT AT WHICH A STRAIGHT EDGE JOINING THE VALUES TAKEN INTERSECTS THE LINE REPRESENTING THE FEEDS OF WHICH THE VALUE IS DESIRED, GIVES THE VALUE OF THAT FEED IN DOLLARS PER TON IN RELATION TO THE VALUE OF BARLEY AND OILMEAL. E. G. BARLEY AT \$2.00 AND OILMEAL AT \$2.00 SHOWS OATS WITH A VALUE OF \$2.10.

by following a similar procedure to that used in Table 1. The value per pound of protein, and per pound of non-protein digestible nutrients is found and the relative prices of the other feeds calculated. In a like manner to Table 1, constants are developed and can be used for the rapid estimation of the value of any feed in the table (Table 2) should the prevailing price of barley or 60% tankage fluctuate.

Tankage and some of the other high protein feeds, fish meal for example, are not necessarily purchased because they are the cheapest source of nutrients. They are relatively much more valuable for their supplementary powers. Table 2 shows the relative evaluation of these special protein feeds which, in the main, are used as swine and poultry supplements.

Figure 1 is a chart for the rapid estimation of the relative value of the more common feeds.

The relative value per ton of any feed on the chart can be determined by placing a straight edge on the value of barley, the heavy line near the bottom, and on that of linseed oilmeal, the heavy line near the top. The point at which the straight edge intersects the line representing the feed of which the value is desired, gives the value of that feed in dollars per ton, in relation to the values of barley and oilmeal used.

The chart is constructed by locating scales for the more common feeds at their proper place in relation to the influence that the values of barley and oilmeal have on the values of these feeds. Further, the feeds being in the proper position in relation to barley and oilmeal, they are consequently in relation to each other. The scale of a feed is developed by determining the value of that feed when barley and oilmeal are \$60.00 per ton each, and dividing the line representing the feed on the chart into its proper units.

By following the sample intersecting line on the chart, which cuts the line representing barley at \$23.00 per ton, and oilmeal at \$32.00 per ton, the value of corn is shown to be about \$23.80 per ton, middlings \$25.65 per ton, gluten feed \$28.90 per ton, etc. These values are seen to closely approximate the values in the table when barley and oilmeal have the value of \$23.00 and \$32.00 per ton, respectively.

There is another use to which this chart may be put which greatly enhances its value. Keeping in mind the certain degree of error under which a chart of this nature is constructed, and given the value of *any* two feeds at any particular time, an approximate value for any other feed relative to these two feeds can be determined by using a straight edge.

SUMMARY

A suggested plan of evaluating feeds, in which both their digestible crude protein and total digestible nutrients are used as the basis of evaluation, has been discussed and corroborated. This procedure has been adapted to suit Canadian feeding practice, and constants and relative valuations are given for the more common live stock feeds.

LITERATURE CITED.

1. HENRY, W. A. and MORRISON, F. B. Feeds and Feeding. 19th Edition, unabridged; 722-744. 1928.
2. PETERSEN, W. E. A formula for evaluating feeds on the basis of digestible nutrients. Jour. Dairy Sci., 15: 4; 293-297. 1932.

L'AGRICULTURE DANS LA PROVINCE DE QUEBEC

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L'agriculture est la principale industrie de la province de Québec. Elle occupe cinquante pour cent près de la population. Elle produit, à elle seule, le quart de la richesse qui se crée chaque année dans Québec. Donnons-en un aperçu sommaire. Divisons notre sujet en six parties: notes historiques, richesse agricole, système de culture, organisations agricoles, enseignement agricole et politique agricole du gouvernement provincial.

NOTES HISTORIQUES

Samuel de Champlain, fondateur de Québec (1608) avait foi dans l'avenir agricole du Canada.

“Ce sera, disait-il, un pays de labourage et de pâturage; avant tout, il faut y conduire des laboureurs.”

En 1613, il écrit:

“Pour éviter les inconvénients qu'il y a eu les années précédentes en faisant trop tard le foin pour le bétail, j'en ai fait la récolte au Cap Tourmente dès le mois d'août.”

Louis Hébert fut le premier colon cultivateur. Il débarqua à Québec en 1617 avec sa femme et ses enfants. Il défricha et cultiva la première terre. On célébra, en 1917, le troisième centenaire de son arrivée à Québec. Le peuple lui érigea à cette occasion un monument sur la terre même qu'il avait défrichée trois cents ans auparavant, près de l'Hôtel de ville actuel.

Guillaume Couillard, gendre d'Hébert, fut le second colon. Il possédait, en 1629, huit arpents de terre ensemencée. En 1643, Abraham Martin cultivait la terre connue par la suite sous le nom de Plaines d'Abraham, devenue, en 1759, le champ de bataille des armées de Wolfe et de Montcalm. Pierre Giffard, Pierre Boucher et Pierre Gadois, le premier près de Quebec, à l'endroit géographiquement connu aujourd'hui sous le nom de Giffard, le second aux Trois-Rivières, le troisième à Montréal, furent aussi des pionniers.

Champlain importa le premier bétail. En 1626, il établit une ferme au pied du Cap Tourmente pour le bétail qu'il expédiait de Québec. Le bétail canadien français de la province de Québec descend de ces animaux. Le premier cheval fit son apparition à Québec en 1647. Il y eut des importations en 1665, 1667 et 1670. Le cheval canadien acquit une grande réputation. Les Américains achetèrent les meilleurs étalons pour constituer leur Standard Bred. Il n'en resta qu'un petit nombre. Les chevaux canadiens de la ferme expérimentale de Cap Rouge (haras de Saint-Joachim) sont des descendants de ces importations. Il y avait aussi, en 1663, à Québec, des porcs, des moutons, des poules, des dindes et des pigeons.

La colonisation de Québec s'est faite sous le régime de la tenure seigneuriale. Ce système dura jusqu'en 1854. Il facilita l'organisation et le développement de la population rurale et le groupement en paroisses.

“Quand le Canada passa sous la domination anglaise, dit l'historien Turcotte, les Canadiens-Français comptaient environ 65,000 âmes. La

conquête les avait laissés dans une position très critique; la plupart d'entre eux étaient ruinés. Ils se virent abandonnés par un grand nombre de nobles, de citoyens influents, d'officiers et de lettrés et perdirent, par cette migration forcée ou volontaire, une population précieuse par ses connaissances et son expérience. Malgré tous ces malheurs, ils ne se laissèrent pas décourager. Avec l'aide du clergé catholique, ils s'isolèrent de leurs conquérants (et par ce fait du reste de l'univers) pour s'occuper de la culture de leurs terres dévastées et travaillèrent avec énergie à réparer leurs pertes."

L'isolement, le manque d'organisation, les spéculateurs de terres barrèrent la route, pendant plus d'un siècle, au progrès de l'agriculture. Les colons canadiens français triomphèrent de ces obstacles. Ils réussirent à se débarasser de ces spéculateurs et à faire du Québec une grande province agricole.

LA RICHESSE AGRICOLE DU QUÉBEC

D'après l'Annuaire statistique, il y avait, en 1931, dans la province de Québec, 135,957 fermes. Leur superficie totale couvrait une étendue de 17,753,302 acres, soit une moyenne de 130.58 acres par ferme. Le recensement de 1931 estime comme suit la richesse agricole du Québec: terres, \$546,777,000, bâtiments, \$285,530,000, instruments et machines, \$111,940,000, bestiaux, \$88,473,000, volailles, \$6,657,000, animaux à fourrure, \$3,000,000, production agricole sur les fermes cette année-là, \$181,457,000, total, \$1,223,723,000, sur un total pour tout le Canada de \$6,768,595,000. L'Annuaire statistique évalue la richesse totale de la province (agriculture, mines, forêts, pêcheries, usines centrales électriques, manufactures, construction, travaux faits à la main, réparation, établissements de commerce, chemins de fer, canaux, téléphones, immeubles urbains, ports, navigation, marchandises importées en magasin, automobiles, voirie, ameublements de ménage, vêtements, etc., numéraires) pour 1929, à \$8,264,513,000. La richesse agricole compte donc pour un huitième dans la richesse totale de la province. La richesse agricole du Québec est aussi grande à elle seule que la richesse des mines, des forêts, des pêcheries et des usines centrales électriques. La valeur nette de la production générale du Québec, en 1930, s'établissait comme suit: agriculture, \$173,275,448, forêts, \$110,779,636, pêcheries, \$2,502,998, chasse, \$1,245,461, mines, \$41,215,220, usines électriques, \$43,201,265, construction, \$1,000,-536,800, ateliers de réparation, \$15,986,000, manufactures, \$560,036,409, total de la production nette, \$892,076,349. La valeur nette de la production du sol était donc presque aussi grande, en 1930, que l'ensemble de la valeur nette de la production des autres ressources naturelles: forêts, pêcheries, chasse, mines, usines électriques.

Québec possède en tout 43,000,000 d'acres de terre cultivable. Il reste donc 26,000,000 de terre cultivable disponible.

En 1931, la population totale de la province se répartissait comme suit: population urbaine: 1,813,606, population rurale: 1,060,649. La proportion pour cent de la population s'établissait donc comme suit: urbaine: 63.1, rurale: 36.9.

Depuis deux ans surtout, le mouvement du retour à la terre et celui de la colonisation prennent des proportions assez considérables. L'année

dernière, on a placé 3,500 familles sur des terres. Si le budget de la colonisation le permettait, ce chiffre, cette année, triplerait. La colonisation est particulièrement intense dans l'Abitibi, le Témiscamingue, le Témiscouata et le Lac St-Jean.

LE SYSTEME DE CULTURE

Les cultivateurs de la province de Québec font en général de la culture mixte ou variée. Elle comprend deux principaux groupes de production: 1°—La production laitière et celle du porc comme productions principales, constituant le plus gros du revenu de la ferme; 2°—les productions spéciales, connues en anglais sous le nom de *cash crops*. Ces principales cultures spéciales sont: l'aviculture, la culture de la pomme de terre, la culture maraîchère la culture fruitière, la culture du tabac, la production commerciale des semences, l'élevage du bétail de race pure, la production du sucre d'érable, l'apiculture, l'élevage du mouton, l'élevage du bétail de boucherie et l'élevage du cheval.

L'industrie laitière et l'élevage du porc constituent le noyau du système de culture des cultivateurs de la province. La rotation des récoltes est agencée de façon à assurer le succès de ces deux principales industries. La rotation de six ans: culture sarclés et fourrage vert, grain avec semis de graines fourragères, foin de trèfle, foin mélangé, pâturage pendant deux ans, et la rotation de quatre ans: culture sarclée et fourrage vert, grain avec semis de graines fourragères, foin de trèfle et pâturage, sont les plus communes. Le choix des cultures spéciales se fait en tenant compte des conditions économiques. La culture maraîchère se pratique au voisinage des villes et dans les centres visités par les touristes. Ainsi, si on trouve des jardins maraîchers sur l'Île de Montréal, on en trouve aussi à Sainte-Agathe, dans les Laurentides. L'élevage du mouton trouve sa plus grande extension dans les régions montagneuses de la Beauce. La culture du pommier se pratique surtout autour des monts Rougemont, Beloeil, St-Grégoire et dans les Cantons de l'Est. Les pommes de la province de Québec (Fameuse et McIntosh) sont universellement connues. La pomme de terre se rencontre surtout sur les sols légers du bas St-Laurent. La culture du tabac se rencontre sur les fermes des comtés de Montcalm, l'Assomption, Joliette, Berthier, au nord du Saint-Laurent, et des comtés de Rouville, St-Hyacinthe et de Missisquoi, au sud. On donne beaucoup d'attention, depuis quelques années, à la production des graines de semence. Le Témiscamingue, le Lac St-Jean, l'Abitibi sont renommés pour la production de la graine de trèfle alsike. Les comtés de Chateauguay, Soulange, Vaudreuil, Berthier, Rouville, Laprairie, Napierville, Chambly, Verchères, St-Hyacinthe, Bagot, Yamaska produisent de la graine de trèfle rouge. L'avoine de semence provient surtout de la région de Berthier. Les régions à foin fournissent d'excellente graine de mil. L'aviculture se pratique un peu sur toutes les fermes. On compte en plus une trentaine de centres avicoles importants. La province compte 8,000 apiculteurs. Nos érables ont produit l'année dernière 6,500,000 livres de sucre et 1,150,000 gallons de sirop. On accorde beaucoup d'attention à l'élevage du cheval. Le système de culture variée de la province de Québec est le meilleur qui soit. Le ministère de l'agriculture, comme on le verra plus loin, travaille sans cesse à le développer.



Aspect typique de certaines fermes sur les rives du bas St-Laurent. A noter le morcellement des fermes en une multitude de petits champs formant une sorte de damier.

LES ORGANISATIONS AGRICOLES

La province de Québec compte un grand nombre d'organisations agricoles. Les principales sont: le Conseil d'Agriculture, les Cercles agricoles, les Sociétés d'agriculture, les Syndicats d'élevage, les Sociétés coopératives, les Syndicats coopératifs, les Sociétés d'horticulture, les Cercles d'aviculteurs, les Cercles d'éleveurs de moutons, le Mérite agricole, et l'Union Catholique des Cultivateurs de la province de Québec.

Le Conseil d'agriculture existe depuis 1869. Il se compose de vingt-quatre membres dont vingt et un nommés par le gouvernement et choisis parmi les agriculteurs et les agronomes marquants de la province. Le ministre de l'agriculture, le surintendant de l'instruction publique et le sous-ministre de l'agriculture en font partie d'office. Ses pouvoirs sont très étendus: reviser et approuver les règlements des Sociétés d'agriculture, organiser des expositions agricoles, des concours de récoltes, des concours de fermes, des fermes modèles ou expérimentales, encourager la culture de certaines variétés de plantes, améliorer l'élevage, répandre l'enseignement agricole, publier un journal d'agriculture et diverses publications agricoles, distribuer des octrois aux sociétés d'agriculture, aux cercles agricoles, aux maisons d'enseignement agricole, etc.

Les cercles agricoles paroissiaux datent de 1875. Le cercle doit compter au moins vingt-cinq membres et la souscription totale doit être d'au moins trente dollars. Le but de ces cercles est de provoquer des essais de culture, d'engrais, de machines et d'instruments d'agriculture perfectionnés, d'encourager l'étude des meilleures méthodes pour l'alimentation du bétail la production du lait, la fabrication du beurre et du fromage et l'assainissement des terres. Il peut aussi tenir une exposition d'automne et organiser des concours. Chaque cercle reçoit annuellement une allocation d'au moins vingt-cinq dollars. Le maximum de cet octroi est de cinquante dollars. En 1931, la province comptait 743 cercles agricoles groupant 41,123 membres. La souscription des membres se montait à \$45,601.34. Outre l'allocation régulière, le ministère de l'agriculture prête de l'argent aux cercles, sans intérêt, pour l'achat d'animaux améliorés.

Les sociétés d'agriculture datent de 1857. Une loi votée à Toronto le 10 juin 1857 (sous le gouvernement d'Union) définissait comme suit le but des sociétés d'agriculture du Bas-Canada:

"Le but des dites sociétés sera d'encourager l'amélioration de l'agriculture, de l'horticulture, des manufactures et des œuvres d'art, en tenant des assemblées pour discuter et entendre des conférences sur les sujets qui se rattachent à la théorie et à la pratique de la culture perfectionnée; de promouvoir la circulation de feuilles périodiques sur l'agriculture publiées en cette province; d'importer ou se procurer de toute autre manière des graines de semence, plantes et animaux d'une nouvelle et meilleure espèce; d'offrir des prix pour des essais sur des questions scientifiques relatives à l'agriculture."

En 1869, la Législature provinciale élargissait ce programme. Elle ajoutait à la loi des sociétés d'agriculture l'organisation de concours de labour, de récoltes sur pied, de fermes les mieux cultivées et l'organisation d'expositions de comtés.

La souscription annuelle est de deux dollars. Chaque société a droit à une allocation annuelle égale à deux fois le montant souscrit et payé par ses membres.

En 1931, il y avait, dans la province, 90 sociétés d'agriculture de comté groupant 23,043 membres. Les souscriptions des membres s'élevaient à \$48,113.15. Les recettes totales des sociétés, grâce surtout aux subventions et aux octrois du ministère de l'agriculture, atteignaient le chiffre de \$399,- 382.04. Les dépenses totales se chiffraient à \$388,309.54.

Le syndicat d'élevage est de la nature d'une société par actions, la responsabilité des membres étant limitée au montant de leurs mises respectives. Il a pour but l'élevage et l'amélioration des animaux de la ferme. Il peut acheter, louer, élever, vendre des animaux de race pure, accorder des primes de conservation aux propriétaires d'animaux reproducteurs aux conditions imposées par le bureau de direction et acheter tous produits et instruments relatifs à l'élevage, à alimentation et à l'hygiène du bétail. Il faut au moins dix associés pour former un syndicat. Le montant de chaque action est de dix dollars payable par versements annuels de deux dollars. Il y a une centaine de syndicats d'élevage dans la province. Le ministère de l'agriculture prête de l'argent sans intérêt à ces syndicats pour l'achat d'animaux de race pure.

Les sociétés coopératives agricoles se composent d'au moins vingt-cinq membres désignés sous le nom de producteurs actionnaires. Elles peuvent s'adoindre toutes personnes désignées sous le nom de producteurs affiliés qui deviennent membres sur paiement d'une contribution annuelle de deux dollars. Le minimum d'actions que doit souscrire chaque producteur actionnaire est de cinq ou de dix. Le montant de chaque action est de dix dollars. La société a le droit d'émettre des actions privilégiées. L'intérêt sur ces actions ne doit pas dépasser sept pour cent. Les porteurs d'actions privilégiées, de même que les producteurs affiliés, n'ont pas le droit d'assister ou de voter aux assemblées de la société.

Les sociétés coopératives ont pour but l'on ou plusieurs des objets, ou tous les objets suivants: l'amélioration et le développement de l'agriculture ou de l'une ou de quelques-unes de ses branches, la fabrication du beurre et du fromage, l'achat et la vente d'animaux, d'instruments d'agriculture, d'engrais commerciaux et d'autres objets utiles à la classe agricole, l'achat la conservation, la transformation et la vente de produits agricoles, sous le nom que les fondateurs choisiront.

Il y a au-delà d'une centaine de ces sociétés coopératives dans la province dont une pour la vente du sucre et sirop d'érable, une pour la classification et la vente du miel, une pour la vente des fourrures, une pour l'emballage et la vente des fruits, une pour l'emballage et la vente des pois verts, une pour la classification et la vente des légumes, deux pour la préparation et la vente du tabac, deux pour la vente du lait en nature, deux pour le mirage et la vente des oeufs, cinq pour la préparation et la vente du grain de semence, six pour la mise en conserve des légumes, treize pour la fabrication du beurre et du fromage, quinze pour la classification et la vente des patates, seize pour l'incubation et la vente des poussiens, 35 pour achats et ventes.

Outre ces coopératives locales ou spéciales, la province compte une grande coopérative centrale d'achat et de vente: la Coopérative Fédérée de Québec. Elle est régie par une loi spéciale. Elle fait pour plusieurs millions de dollars d'affaires par année. Les coopératives locales y sont pour la plupart affiliées.

Pour encourager le mouvement coopératif, le ministère de l'agriculture accorde un octroi de $1\frac{1}{2}\%$ sur le chiffre de ventes de produits agricoles à toutes les sociétés organisées ou opérant suivant la législation du 4 avril 1930: loi des sociétés coopératives agricoles.

Les syndicats coopératifs sont régis par la loi concernant les syndicats coopératifs qui dit que des syndicats coopératifs de consommation, de production, de crédit, de prévoyance et pour autres fins économiques peuvent être formés sur tout le territoire de la province. Il faut au moins douze associés pour former une société coopérative en vertu de cette loi. Le montant de chaque action est fixé par les règlements. Il ne doit pas être inférieur à un dollar.

Des syndicats coopératifs pour l'achat et la vente sont organisés par l'Union catholique de la province de Québec. Ils sont affiliés au Comptoir coopératif de cette association. Il y en a une centaine dans la province.

Cette loi concernant les syndicats coopératifs régit l'institution de crédit populaire de la province de Québec connue sous le nom de caisse populaire Desjardins.

La province de Québec compte plusieurs sociétés d'horticulture. La principale est la Société de Pomologie et de Culture Fruitière de la province de Québec. Elle étudie les moyens propres à aider la pomologie et la culture fruitière. Ses membres sont au nombre de 400.

Les Cercles d'aviculteurs ont pour but le développement et l'amélioration de l'aviculture. Pour organiser un cercle, il faut au moins dix membres. Les membres s'engagent à construire un poulailler moderne, une colonie-élevageuse, à acheter, chacun, 300 poussins d'un jour, à suivre la direction des instructeurs avicoles, à tenir une comptabilité. Le ministère de l'agriculture fournit une élevageuse, paye, la première année, 50% des poussins, distribue des plans de poulailler et met des instructeurs au service des cercles. Il y a une centaine des ces cercles comptant près de 1,200 membres. En 1931, la profit moyen par poule s'élevait à \$1.63.

Pour encourager l'élevage du mouton, on a recours aux cercles d'éleveurs de moutons. Chaque cercle doit compter au moins dix membres. Chaque membre doit acheter au moins dix brebis et un bêlier de pure race. Le ministère de l'agriculture prête, sans intérêt, les deux tiers du prix d'achat des brebis. Une prime de dix dollars est accordée pour chaque bêlier. Des prix pour un montant de \$200.00 sont distribués aux expositions locales. Le ministère fédéral de l'agriculture coopère.

Le Mérite Agricole fut fondé, il y a une quarantaine d'années, par feu Honoré Mercier, alors premier ministre de la province. L'Ordre du Mérite agricole, dit la loi, est institué dans le but d'encourager les agriculteurs par des honneurs et des récompenses et de reconnaître les services rendus à l'agriculture. Les décosations et diplômes suivants peuvent être accordés

par le gouvernement: la décoration de Commandeur de l'Ordre du mérite et le diplôme de très grand mérite exceptionnel ou de très grand mérite spécial; la décoration d'officier de l'Ordre du mérite agricole et le diplôme de très grand mérite; la décoration de chevalier de l'Ordre du mérite agricole et le diplôme de grand mérite; diplôme de mérite. Trois prix en argent sont décernés aux trois meilleurs cultivateurs de la première catégorie: \$200.00, \$150.00 et \$100.00.

L'Union catholique des cultivateurs de la province de Québec est une association indépendante des pouvoirs publics. C'est une association professionnelle. Elle exerce son action dans le domaine social comme dans le domaine économique. Elle défend les intérêts de l'agriculture. Comme on l'a vu plus haut, elle organise des syndicats coopératifs qu'elle affilie à son Comptoir de Montréal. Elle compte une quinzaine de mille membres répartis en plusieurs centaines de cercles paroissiaux. Elle publie un journal hebdomadaire: *La Terre de Chez Nous*.

L'ENSEIGNEMENT AGRICOLE

L'enseignement agricole de la province de Québec comprend l'enseignement supérieur ou universitaire, l'enseignement moyen et l'enseignement élémentaire. L'enseignement supérieur se donne à L'Institut Agricole d'Oka, au Collège d'Agriculture de Sainte-Anne de la Pocatière et au Collège Macdonald de Sainte-Anne de Bellevue. Le premier est affilié à l'Université de Montréal, le deuxième, à l'Université Laval et le troisième, à l'Université McGill. Le cours est de quatre années. Ces trois collèges ont aussi organisé l'enseignement moyen. Le cours est de deux ans. Il est destiné aux fils de cultivateurs qui n'aspirent pas aux fonctions publiques. Ce même enseignement moyen se donne dans deux écoles spéciales: l'Ecole Moyenne d'Agriculture de Rimouski et l'Ecole Moyenne d'Agriculture de Sainte-Martine. Pour étendre davantage cet enseignement pratique, le ministère de l'agriculture vient d'inaugurer une nouvelle politique en faveur des académies ou collèges commerciaux qui désirent organiser une section d'enseignement agricole moyen. Le ministère met à la disposition de ces maisons d'enseignement les avantages suivants: les deux tiers du salaire d'un professeur d'agriculture, porteur d'un titre de B.S.A., jusqu'à concurrence de \$1,000 par année; une bourse de \$9.00 par mois par élève; les mêmes octrois à la ferme du collège qu'aux fermes de démonstration. Les cours de cette section agricole s'ouvrent vers le 15 octobre et se terminent vers le 15 avril. Chaque collège doit exploiter une ferme et s'en servir pour l'enseignement. Quatre ou cinq collèges ont organisé déjà cette section agricole. L'enseignement élémentaire fait partie du programme des écoles primaires. Les Cercles de jeunes agriculteurs et les Cercles de jeunes éleveurs, nombreux dans la province, sont aussi des foyers d'enseignement moyen ou pratique. Le Mérite agricole des jeunes, institution ressemblant à l'Ordre du Mérite Agricole dont nous avons parlé plus haut, apporte son encouragement.

LE MINISTÈRE D'AGRICULTURE DE QUÉBEC

Le ministre de l'agriculture de la province de Québec est l'honorable Adélard Godbout, l'un des nombreux fils de M. Eugène Godbout, cultivateur modèle de St-Eloi de Témiscouata, ancien député. M. Adélard Godbout

est un ancien professeur d'agriculture du Collège de Ste-Anne de la Pocatière. C'est un technicien agricole. Il exploite une ferme. Le sous-ministre est M. Antonio Grenier. Le ministère se compose de quatre services; le service de l'économie rurale, qui a pour chef M. Henri-C. Bois, le service de l'industrie animale, qui a pour chef M. Adrien Morin, le service de l'horticulture, qui a pour chef M. J.-H. Lavoie, le service de l'administration, qui a pour chef M. Narcisse Savoie. Ces quatre services constituent le bureau de direction du Ministère. Ce bureau technique a pour président M. L.-P. Roy, directeur des services. Le service de l'économie rurale comprend les sections suivantes; section du drainage, section des semences et des engrains, section des champs de démonstration, section des fermes de démonstration et des concours d'exploitation rationnelle des fermes, section des enquêtes agricoles, section de la coopération, section de l'apiculture et de l'industrie du sucre d'érable, section des statistiques, section de l'économie domestique, section des publications. Le service de l'industrie animale comprend les sections suivantes: section des chevaux, section des bovins, section des porcs et des moutons, section de l'aviculture, section de la médecine vétérinaire, section de l'industrie laitière, section des constructions rurales. Le service de l'horticulture comprend les sections suivantes; section de la culture fruitière, section de la culture maraîchère, section de la culture du tabac, section des conserves alimentaires, section de la protection des plantes, section des jeunes agriculteurs. Le service de l'administration s'occupe de la correspondance du ministère, de la finance, de la régie interne. Outre ces quatre services, le ministère de l'agriculture comprend 81 agronomes de comté, 26 sous-agronomes, une cinquantaine d'inspecteurs de fromageries et de beurries, un grand nombre d'instructeurs en grande culture, en industrie animale, en aviculture, en horticulture, etc. Tous ces agronomes, inspecteurs, instructeurs sont sous la direction d'agronomes régionaux. On a divisé à cette fin la province en vingt régions. Chaque région a son agronome régional. L'agronome régional est le technicien agricole en chef de la région. Il dirige tout le travail de propagande agricole de sa région. Tous les techniciens agricoles de la région relèvent de lui et lui-même relève du bureau de direction du ministère de l'agriculture. On a appliqué dans cette organisation le principe de la décentralisation.

Nous ne parlerons pas des activités des différents services du ministère. Ce serait trop long. On trouvera tout cela dans le rapport annuel du ministre de l'agriculture, rapport de 250 pages.

Le budget du ministère de l'agriculture, pour l'année se terminant le 30 juin 1932, s'élevait à \$3,600,000.

Grâce à la belle et saine population rurale de la province de Québec, au travail des agronomes et des écoles d'agriculture, à la politique agricole du ministère, l'agriculture de Québec a fait, depuis dix ans, d'immenses progrès. Elle souffre actuellement de la dépression économique. Les cultivateurs ne se découragent pas. Ils ont confiance que l'ordre du monde se rétablira et qu'ils pourront reprendre leur marche en avant.

RESUME DES ARTICLES PUBLIES EN ANGLAIS DANS CE NUMERO

SYSTEMES D'AGRICULTURE AU CANADA. Wm.. Allen, Université de la Saskatchewan, Saskatoon, Sask.

L'auteur, après avoir fait une analyse statistique des systèmes d'agriculture dans les diverses parties du Canada, conclue de la manière suivante. A l'exception des provinces maritimes et centrales il y a peu d'uniformité ou de continuité des zones agricoles ainsi qu'il apparaît de la carte ci-jointe. Dans la plupart des cas l'agriculture des diverses zones canadiennes ressemble de près à celle des zones voisines des Etats Unis dont elles font naturellement partie. Les obstacles géographiques énormes qui séparent les différentes zones augmentent les difficultés de communication, de transport et de distribution. Les populations des différentes sections ont de la difficulté à comprendre les problèmes des autres sections aussi bien en agriculture qu'en industrie. La récente dépression a rendu plus aigus les problèmes de chaque zone et les cultivateurs dans chaque zone ont concentré leur attention sur leurs propres problèmes. Les barrières entre les régions économiques du Canada retardent le mouvement général des marchandises. La plupart des régions agricoles du Canada produisent plus qu'elles ne peuvent absorber, et les surplus qui en résultent doivent être revendus sur des marchés extérieurs où ils ont à faire face à une concurrence sérieuse et où ils rencontrent des obstacles d'ordre politique aussi bien qu'économique.

ETUDE COMPAREE DE L'INFECTION DES JEUNES PLANTS DE BLE PAR PUCCINIA GRAMINIS TRITICI EN SERRE ET EN GRANDE CULTURE. K. W. Neatby, Laboratoire fédéral de recherche sur la rouille, Winnipeg, Man.

L'auteur donne des résultats d'études comparées faites sur la résistance à la rouille de la tige en serre et en grande culture de jeunes plants d'hybrides Marquillo X Reward, Garnet X Marquillo, and Garnet X Double Cross.

RESISTANCE A L'HIVER DES SPORES DE LA CARIE DU BLE. W. F. Hanna et W. Popp, Laboratoire fédéral de recherches sur la rouille, Winnipeg, Man.

Des spores de carie (*Tilletia tritici*) dans des épis infectés de blé Mindum placés à la surface du sol ont résisté à l'hiver aux stations suivantes: Winnipeg, Morden, Brandon, Indian Head, Saskatoon, et Edmonton. Avec une seule exception (Winnipeg) les spores, contenues dans des épis enterrés à six pouces de profondeur ont moins bien passé l'hiver que les spores restant à la surface.

MICROBIOLOGIE DU SOL ET PATHOLOGIE VEGETALE. G. B. Sanford, Laboratoire fédéral de pathologie végétale, Université de l'Alberta, Edmonton, Alberta.

L'effet de certains micro-organismes attaquant les parties souterraines des plantes varie suivant certaines pratiques culturales comme l'assolement ou la jachère. A l'heure actuelle on ne sait pas si la réduction dans l'intensité d'une maladie à la suite d'une certaine pratique culturale est due à une diminution du nombre d'organismes pathogènes dans le sol ou si la virulence des organismes pathogènes est modifiée par d'autre micro-organismes hostiles. L'auteur a particulièrement en vue la pourriture des racines des céréales, la gale commune des pommes de terre et le chancre de la tige des pommes de terre.

UTILISATION DU MAIS NON MUR POUR LES SEMAILLES. John Walker, Ministère de l'Agriculture, Winnipeg, Man.

Les travaux ont été faits avec la variété potagère Burbank Golden Bantam M.A.C., les grains ayant été récoltés de 13 à 55 jours après l'apparition des soies. Les résultats de cette expérience indiquent qu'on peut raisonnablement s'attendre à une bonne germination et à une production de plantes vigoureuses de grains non mûrs à condition qu'ils soient bien développés et qu'ils aient été soigneusement conservés. Les épis et les grains qui se développent de bonne heure atteignent une bonne dimension en moins de temps que ceux qui se développent tard. Pour la production de la semence il est donc désirable de semer le maïs de bonne heure afin que les épis soient raisonnablement mûrs et bons à récolter avant les gelées d'automne.

INFLUENCE DE LA JACHERE SUR LE NOMBRE DE VERS FIL-DE-FER. K. M. King, et R. Glen, Laboratoire fédéral d'entomologie, Saskatoon, Sask.

Le but de l'expérience est de déterminer sur une échelle de grande culture au moyen de parcelles répliquées l'effet de 4 méthodes différentes de jachère sur le nombre de vers fil-de-fer et sur les dégâts causés au blé. En raison des nombreuses années nécessaires pour compléter le cycle vital d'un ver fil-de-fer il n'est pas encore possible de formuler des conclusions définitives. Il semble cependant qu'un labour très profond provoque une augmentation du nombre de vers fil-de-fer. Des façons culturelles superficielles tendent à réduire les dégâts causés par le ver fil-de-fer et en tous cas ne tendent pas à augmenter le nombre de ces insectes. En outre, cette méthode est la moins coûteuse de toutes celles essayées et semble présenter plusieurs autres avantages notamment pour le contrôle des mauvaises herbes.

METHODE D'EVALUATION DES ALIMENTS POUR LE BETAIL SUR LA BASE DES COMPOSANTS DIGESTIBLES. John G. Stothart.

L'auteur discute et corrobore un plan d'évaluation de la valeur des aliments du bétail basé sur leur teneur en matières azotées digestibles et en matières alimentaires totales digestibles. Le procédé a été adapté aux habitudes canadiennes en matière d'alimentation du bétail. Des constantes et des valeurs relatives sont données pour les aliments les plus communs.

LES LIVRES

GUIDE "DES JEUNES" AGRICULTEURS. Adrien Desautels.

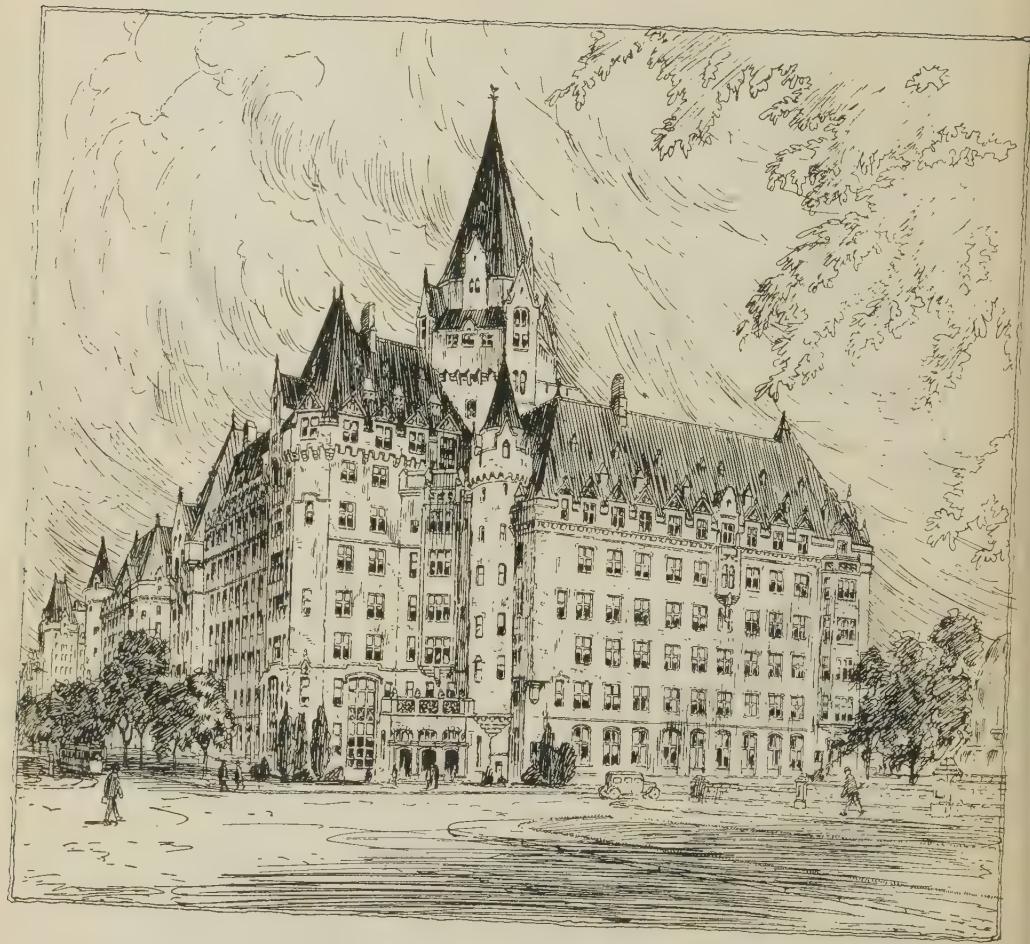
"On dit que la terre manque de bras. Ne manque-t-elle pas surtout de cerveaux? Le blé abonde aux entrepôts, mais pas les livres agricoles aux rayons des bibliothèques, les entrepôts de la pensée. L'agriculture, on l'exalte à pleine bouche, ou à plein stylo, mais pas toujours à plein cœur. L'inspiration est généralement trop peu rurale, l'orientation trop peu pratique. Ce qui fait défaut, ce ne sont ni les rhétaurs, ni les acteurs agraires, mais les valeurs agissantes.

Le Guide des Jeunes Agriculteurs de mon jeune ami Adrien Desautels, (Inspecteur des Cercles de Jeunes Agriculteurs), répond donc à une nécessité, comble une lacune. C'est essentiellement un livre d'action. Une bonne sève printanière circule dans toutes ses ramifications. Ce livre, à sa naissance, reçoit l'approbation du haut clergé et, je dirai aussi, de la *haute agronomie*. C'est un guide sûr pour ceux qui s'intéressent au sort des jeunes agriculteurs, c'est-à-dire pour les agronomes, curés, institutrices, etc.

"Eclairons la route . . . Formons une élite de jeunes agriculteurs!" Ces deux pensées résument le plan de l'auteur. M. Desautels, en homme pratique, en réalisateur, ne se contente pas de montrer aux jeunes un idéal attrant, des perspectives brillantes, mais il leur indique la voie qui y conduit. Il indique surtout le *groupement* d'une jeune élite comme la méthode la plus sûre pour arriver au succès. Son travail se divise donc en quatres parties: 1o Nécessité des cercles de jeunes agriculteurs; 2o Organisation et fonctionnement d'un cercle; 3o Manuel de programmes spéciaux ou Cahier du Secrétaire-trésorier; 4o Cahier de notes à l'usage des membres.

Ce ne sont pas des idées toutes faites que le "Guide des Jeunes Agriculteurs" offre à ses lecteurs, mais des suggestions, des problèmes et des méthodes. Il ne conduit pas ses disciples sur une voie bétonnée, mais il leur montre un sentier terreux, habilement jalonné qui débouche sur un horizon de lumière. Bref, l'auteur s'efforce à assurer le développement des fonctions maîtresses: l'observation juste et l'interprétation raisonnée des phénomènes culturaux. Des améliorations à portée lointaine impressionneront moins ceux qui penchent vers la tombe en parlant "de leur temps", que ceux qui s'éloignent du berceau en parlant de leur avenir. Souhaitons donc que, fortifiée par son attachement au sol, éclairée par les leçons de l'agronomie, et soutenue par un vigoureux espoir, la génération montante se prépare à féconder les sillons ouverts par ses valeureux devanciers. On dit que les bons livres font leur chemin. Le "Guide des Jeunes Agriculteurs" a la voie ouverte.

—GEORGES BOUCHARD.



CONFEDERATION BUILDING, OTTAWA
Headquarters of the Dominion Department of Agriculture

CONCERNING THE C.S.T.A.

ORGANIZATION OF GOVERNMENT AGRICULTURAL SERVICES IN CANADA

It has been felt advisable to present in this issue of *Scientific Agriculture* a brief description of the various agricultural services in Canada in order that visitors to the World's Grain Exhibition and Conference may have a better understanding of the general organization throughout the Dominion. The British North America Act, which brought about the confederation of the provinces in 1867, assigned education as a function of the provinces. Consequently agricultural colleges and schools and county extension systems have been developed largely with provincial funds and under provincial control. Only during the Great War period has any amount of federal funds been turned over to these provincial institutions and departments. The federal government carries on general research, extension, and control activities related to the various acts which it must administer, and also does a great deal of experimental work in both production and marketing of farm crops and live stock.

DOMINION DEPARTMENT OF AGRICULTURE

The Dominion Department, with headquarters at Ottawa, is divided into nine branches as follows: Experimental Farms, Health of Animals, Live Stock, Dairy and Cold Storage, Seed, Fruit, Entomological, Publications and Agricultural Economics. The Experimental Farms Branch is the largest unit doing research and experimental work in agriculture in Canada. The Agricultural Economics branch is engaged principally in economic research, co-operating with the Agricultural Section of the Dominion Bureau of Statistics which is under the Department of Trade and Commerce. The Publications Branch, as its name implies, is a clearing house for the publication of all branches. The other branches of the Department of Agriculture are concerned mainly with the enforcement of some fifteen acts of parliament relating to the grading, movement, and protection of agricultural products for both domestic use and export. These branches do a considerable amount of extension work and also such research as may be necessary to maintain the efficiency of their service. This includes the major proportion of research work done in Canada on plant and animal diseases and insect pests.

PROVINCIAL DEPARTMENTS OF AGRICULTURE

Each of the nine provinces maintains its own department of agriculture which is concerned mainly with extension work relating to production. This work involves the education of farmers by commonly used extension methods, and involves such control work as is covered by provincial legislation. In many cases the provincial governments also pass enabling legislation to cover policies put into effect by the federal government, and enforcement and education become joint projects. Each province does not maintain the same number of branches in its department of agriculture but varies the organization according to the needs of the province. Nova Scotia, Quebec, Ontario and British Columbia have maintained extensive county agent systems while New Brunswick, Prince Edward Island, and the three prairie provinces have leaned more toward the subject matter specialist type of extension worker than to the resident county agent or agricultural representative type. The salaries and expenses of these extension workers are borne out of provincial funds, and there is no organization through which the farmer maintains an individual membership for the support of this type of work. Extension work and provincial legislation on the marketing of agricultural products is increasing rapidly at the present time.

AGRICULTURAL AND VETERINARY COLLEGES

There are eight agricultural colleges in Canada awarding the degree of B.S.A. or B.S. There are two French colleges in Quebec. One is the College of Agriculture at

Ste. Anne de la Pocatière, associated with Laval University at Quebec city, and the other is the Oka Agricultural Institute at La Trappe associated with the University of Montreal. Both of these institutions are supported by religious orders and by the Quebec Department of Agriculture. Macdonald College, an endowed institution which also receives support from the Quebec Department of Agriculture, is located at Ste. Anne de Bellevue near Montreal and is part of McGill University. The Ontario Agricultural College, the oldest and largest agricultural college in the British Empire, is located at Guelph, is supported by the Ontario Department of Agriculture, and is affiliated with the University of Toronto. In the western provinces the agricultural colleges are all part of the Universities and do not receive support or direction from the Departments of Agriculture. These universities are all provincial institutions receiving their financial support through the provincial Department of Education. They are located at Winnipeg, Manitoba; Saskatoon, Saskatchewan; Edmonton, Alberta; and Vancouver, British Columbia.

The colleges turn out many men who go back to the farms. The amount of post-graduate work is increasing and the agricultural colleges are rapidly taking advantage of the facilities offered by other departments of the universities with which they are associated. This movement has been stimulated by scholarships given through the National Research Council and other organizations. The colleges in their field and extension work co-operate closely with the departments of agriculture, usually furnishing subject matter specialists for meetings, campaigns, programme planning, etc.

The Ontario Veterinary College is supported by the provincial government and is located at Guelph beside the Ontario Agricultural College. It does research in animal diseases and turns out the majority of the veterinary graduates who practice in Canada. Quebec has a veterinary college in connection with the Oka Agricultural Institute at LaTrappe. Several of the provinces have agricultural schools which give vocational courses and, in some cases, the first two years of the degree course.

RELATION OF AGRICULTURAL SERVICES IN CANADA

In addition to the three major divisions of the agricultural services, namely the Dominion Department of Agriculture, the Provincial Departments of Agriculture and the Agricultural Colleges, there is considerable agricultural work being done by two or three provincial Research Foundations, by certain departments in the Universities, by the Dominion Bureau of Statistics and by the National Research Council. The latter organization works particularly through its associate committees and through scholarships. Considerable extension work is undertaken by commercial organizations and by national and provincial farmer's organizations.

The co-ordination of this extensive effort under the control of various political units over an enormous country presents somewhat of a problem. In general, the various services have been developed along certain well defined lines. The men themselves, mindful of the need for efficiency and economy, have worked out much of their own salvation through co-operation. The Canadian Society of Technical Agriculturists has played a major part during the last decade in bringing together the leaders of the various services in annual conventions and in local organizations at all the college and departmental centers. Committees have worked steadily to lay down principles of co-operation which, while they have not become immediately effective, have guided thinking throughout the Dominion to the point where leaders have now found it possible to set up machinery for more effective co-ordination.

In August 1932 a National Conference was held under the leadership of the Federal Minister of Agriculture at which major agricultural problems were discussed and certain measures of attack were agreed upon. The conference authorized the formation of a National Advisory Committee on Agricultural Services. The function of this committee is to stimulate co-operation between services jointly involved on a project and to gradually develop closer co-ordination between all agricultural services.

The next session of this committee will be held at Regina previous to the World's Grain Exhibition and Conference.

The Canadian Society of Technical Agriculturists through its Committee on Education and Extension has undertaken during the past two years to complete a detailed survey of opinion concerning methods of extension work. This survey will represent the opinion of committees made up of extension leaders and others working in all the provinces. It will recommend closer co-operation between the various services in programme planning and will evaluate some of the extension methods now in use.

The C.S.T.A. Committee on Research has undertaken the task of assembling project reports in all the research in agriculture now under way in all institutions in Canada. This has been a heavy task and its success has been made possible only through the co-operation of several affiliated societies and groups and of the research men themselves. Each set of projects will be mimeographed for distribution and will be indexed by subjects and by institutions. A brief summary will indicate the general trends of research in each particular field during the past few years. Further study will enable leaders in each field to make plans to alter these trends if necessary. The work of the C.S.T.A. Committee on Research is of great value to students, to workers in each field, and to administrative officers. It is one further step in bringing about greater efficiency in the whole system of agricultural services.

WORLD'S GRAIN SHOW NUMBER OF SCIENTIFIC AGRICULTURE

The current issue of *Scientific Agriculture* is presented as a special World's Grain Exhibition and Conference number. It was not arranged with the idea of presenting any great amount of publicity in connection with the Exhibition, but rather to emphasize the work of the technical agriculturists in their efforts to serve particularly the great grain areas of western Canada.

For the benefit of those from outside of Canada who are visiting the Grain Conference we have included an article on "Types of Farming in Canada," by Dr. Wm Allen of the University of Saskatchewan. No doubt many of our Canadian readers will appreciate the concise summary of our farming conditions given in this paper. A similar paper by Prof. Létourneau discusses in more detail the farming conditions of the province of Quebec. Other papers give detailed accounts of the work of various departments in solving some of the problems assigned to them. In order that the live stock side may not be overlooked we have included a paper giving a very convenient new rule-of-thumb system for evaluating feeds on the basis of their total digestible nutrients.

The Canadian Society of Technical Agriculturists owns and publishes the monthly journal, *Scientific Agriculture*. The society is made up of some eleven hundred members organized in twenty-one branches throughout Canada. For the past ten years it has exerted a wholesome influence on the development of the agricultural services of the nation. An account of the organization of these services and some of the work of the Society is given in a brief article in this section of the journal.

Delegates and visitors are cordially invited to attend the session of the Society on July 24th just previous to the opening of the Grain Conference. Afternoon technical sessions of the Grain Conference will be joint sessions with affiliated societies and groups of the C.S.T.A. The General Secretary of the C.S.T.A. is acting as Secretary of the World's Grain Conference Programme Committee and the Society is publishing the Report of the Proceedings of the Conference. An information booth will be maintained by the C.S.T.A. in the Exhibition Building and visitors and delegates are cordially invited to make it their headquarters on the Exhibition Grounds.

REGINA CONFERENCE ASSURED OF SUCCESS

As the opening of the World's Grain Exhibition and Conference draws near it becomes apparent that it will be a landmark in the history of western Canada. While world conditions have altered markedly since the original plans for the show were made, it has been possible to retain the main features and strengthen them in many respects.

The Grain Exhibition, coming at the same time and on the same grounds as the Saskatchewan Provincial Exhibition, will ensure the largest and most varied show ever staged in Western Canada. Many of the government displays were built originally for Wembley and Argentina and there are additional educational exhibits presenting the work of the different agricultural services of the Dominion. Foreign governments are staging attractive displays of their natural resources and products, and commercial and industrial organizations have taken thousands of feet of space. The competitive exhibits of grain number 2,700 from over forty countries, states and provinces.

The Grain Conference has developed into one of the most important educational gatherings ever held in Canada. Science turns its light on the whole range of activities in the production and marketing of grain from the bacterial life in the soil that forms the seed-bed to the final analysis of the protein content of the wheat and the baking of the bread in European laboratories. One will be able to follow the work of the scientist in every phase of the world production and movement of bread grains in papers which will be read at the Conference and published later in the Proceedings. Taken in all its phases, the World's Grain Exhibition and Conference will be not only of immense educational value to western Canada, but an important step in the better understanding of the great international problem of food production and distribution.

C.S.T.A. AND C.S.G.A. HEADQUARTERS AT REGINA

Members of the C.S.T.A. will be quartered at Regina College during the World's Grain Exhibition and Conference. Bed and breakfast will be available at \$1.50 per person for double rooms. Other meals must be secured elsewhere. The Canadian Seed Growers' Association will be accommodated at the same rates at St. Chad's College about two blocks from Regina College. An invitation has been received from the C.S.G.A. for all C.S.T.A. members to attend their sessions on July 21st and 22nd. It is hoped that many C.S.G.A. members will attend the C.S.T.A. sessions during the week of July 24th. Members who desire accommodation in Regina College or adjacent homes should make application at once to the General Secretary, Box 625, Ottawa or to Mr. Harry Saville, 2275 Princess St., Regina, secretary of the Southern Saskatchewan branch of the C.S.T.A. The C.S.T.A. business session will be held on Monday, July 24th, and a banquet will be held later in the week. Joint sessions of affiliated societies and groups of the C.S.T.A. will be held throughout the Grain Conference.

C.S.T.A. members are expected to take out membership in the Grain Exhibition which entitles them to all privileges in connection with the Show and Conference. There will be no C.S.T.A. convention registration fee. Grain Exhibition Associate Memberships cost \$5 and cover everything but a copy of the Proceedings. Those desiring this publication should take out a full membership at \$10.

REGINA PROGRAMME DATES

Dates have been set for the various meetings to be held in connection with the World's Grain Exhibition and Conference at Regina. The final programme will be published early in July. Many outstanding papers have been received and a large group of prominent leaders in scientific thought will be present.

July 21-22. . . Canadian Seed Growers' Association. Programmes are available from the Secretary-treasurer, Mr. W. T. G. Wiener, Jackson Building, Ottawa.

July 23. . . . Motor trip to the Dominion Experimental Farm, Indian Head, and to the Qu'Appelle Lakes.

July 24. . . . Canadian Society of Technical Agriculturists. Business session in morning and afternoon and illustrated lecture in the evening.

July 25. . . . Official opening of the World's Grain Exhibition and Conference at 10.30 a.m.

Technical Sessions of the Conference in the afternoon.

July 26-28 . . . Open Sessions of the Grain Conference in the morning and Technical Sessions in the afternoon. Open Sessions include half-day discussions by outstanding authorities on each of the following subjects:

- The Present World Wheat Situation and Trends.
- World Import Cereal Requirements.
- World Wheat Surplus. Is Controlled Production Necessary?
- Financing World Wheat Surpluses. Are Changes Necessary?
- Merchandizing Methods in Wheat Marketing. Can Improvements be Affected?
- Transportation and Storage of World Export Grains. Are Further Economies Possible?
- Live Stock. Its Place in Marketing Grains.

The afternoon sessions include meetings of the following organizations:

- Western Canadian Society of Agronomy
- Canadian Society of Agricultural Economics
- Canadian Phytopathological Society
- Canadian Society of Animal Production—Western Section
- International Great Plains Crop Pest Committee
- Agricultural Engineering Group of the C.S.T.A.
- Soils Group of the C.S.T.A.
- Horticultural Group of the C.S.T.A.
- Cereal Chemistry Section

July 29-30 . . . Week-end trip including a visit to the Dominion Experimental Station at Indian Head.

July 31-Aug. 3 Continuation of Open Sessions and Technical Sessions.
Grain judging competitions.

Aug. 4 . . . Closing of World's Grain Exhibition and Conference by His Excellency Lord Bessborough.



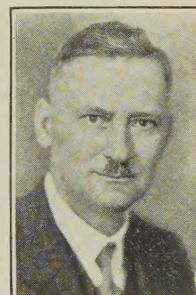
DR. G. I. CHRISTIE
President
C.S.T.A., 1932-33



HON. A. GODBOUT
Vice-President
C.S.T.A., 1932-33
and Pres.-Elect



MR. L. H. NEWMAN
Vice-President
C.S.T.A., 1932-34



MR. GEO. H. CLARK
Hon. Secretary
C.S.T.A., 1932-34

BRITISH TRADE AGREEMENTS WITH DENMARK AND ARGENTINA

Trade agreements between Britain and both Denmark and Argentina have recently been concluded. These agreements should be of more than ordinary interest to the agricultural industry in Canada. A fairly complete discussion of these treaties is given in the Ayrshire Post of May 19, 1933. The major points of interest to the agricultural industry generally and to Canada particularly may be very briefly summarized.

DENMARK

In the arrangement with Denmark the amounts of the quotas of butter and eggs are definitely stated and a definite percentage (62%) of the foreign imports of bacon and ham may be allowed that country—unless a greater reduction in total imports from all foreign countries should be essential to secure the maintenance of a remunerative level of prices. On the other hand if the total imports from all foreign countries are increased Denmark is to share in that increase. In case any other foreign country gives up its quota the quota of Denmark will be increased in proportion to that of other countries. An endeavor will be made by the British Government to give the Danish Government six months notice of the quantity of its bacon quota allowance for the following year.

ARGENTINA

The arrangement with the Argentine resembles in some ways that concluded with Denmark. Imports of chilled beef will be allowed of a quantity equal to the amount imported during the year ending June 1932—unless it appears necessary further to restrict imports in order to secure a remunerative level of prices on the British market. Argentina is not to suffer a reduction of more than 10% below the total of the year mentioned without a corresponding reduction in all other countries. No new duties nor quota restrictions are to be placed on wheat, corn, linseed, bran and middlings while oats and barley are not mentioned. From these arrangements it appears that while Denmark receives an assured position among foreign countries, Argentina receives an assured position among all countries supplying the market, both Empire and Foreign. Argentina continues to import coal duty free and agrees to afford special benevolent treatment to undertakings financed by British capital to assist British financiers who have money "frozen" in Argentina to receive payment in cash.

These trade agreements indicate the modern trend in international trade in farm products. Some of these recent developments may be briefly summarized.

1. Definite recognition of the need for a remunerative price for the home producer of farm products.
2. The possibility of and necessity for mutually beneficial trading arrangements between nations. One way trading is made more difficult, the quid pro quo more generally required and the exaction of two quids pro quo more limited.
3. Present or potential possibility of a surplus of farm products is recognized and definite limits set to the use of the British market for the disposal of world exports of these products.
4. The necessity for collecting debts by accepting goods is not only recognized but facilitated.
5. The possibility of securing food products on order is approached.

—W. E. LATTIMER.